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THE

LITHOLOGY OF EDINBURGH.

THE

LITHOLOGY OF EDINBURGH;

BY THE LATE

REV. JOHN FLEMING, D.D., F.R.S.E.,

PROFESSOR OF NATURAL SCIENCE, NEW COLLEGE,
EDINBURGH.

EDITED, WITH A MEMOIR,

BY THE

REV. JOHN DUNS,

TORPHICHEN.

BODLEIANA · BIBLIOTHECA

EDINBURGH:
WILLIAM P. KENNEDY, 15 ST ANDREW STREET.
GLASGOW: D. BRYCE. LONDON: HAMILTON, ADAMS & CO.
DUBLIN: M'GLASHAN & GILL.
MDCCCLIX.

EDINBURGH :
PRINTED BY JOHN GREIG & SON, OLD PHYSIC GARDENS

INSCRIBED,

WITH KINDEST REGARDS,

TO

THE REV. PRINCIPAL CUNNINGHAM, D.D.

AND TO

THE STUDENTS OF THE NEW COLLEGE,

EDINBURGH.

PREFACE.

WHEN Professor Fleming's private papers were entrusted to me, my first design was to incorporate several of them in a review and criticism of the History of Natural Science during the last fifty years. In this case my sketch would have been purely scientific. But, however congenial the task, I felt there would be the risk of giving greater prominence to my own views, than to the works of him whose biography I had undertaken to sketch briefly. This consideration led me to adopt a plan in which, I trust, the lineaments of Dr Fleming have been drawn with a more decided hand, and his scientific attainments set in stronger relief than could otherwise have been done.

I have selected such passages for quotation as seemed to me fitted to illustrate Dr Fleming's literary attainments, and to shew, especially, the great influence which he exercised on the progress of the different departments of Natural Science, with which his name will ever be associated.

It was Dr Fleming's intention to have inscribed *The Lithology* to the Students of the New College. I have carried out his intention in this respect. The name of Principal

Cunningham has been added, as an expression, on my part, of gratitude for all the kindness and instruction received from him, when, as a student, I enjoyed the privilege of waiting on his ministry in the College Church.

J. D.

Free Church Manse, Torphichen,
15th December 1858.

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MEMOIR.

CHAPTER I. 1785 TO 1810.

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THE chief events in the life of the scholar and the man of science are found in the publication of works, through which they either guide the thinkers of their age to fresh objects of knowledge, or explain to the world discoveries by which the manifold wisdom of God in creation is set in new lights, and the social comfort of mankind increased. In the following outline-sketch of Dr FLEMING'S life, I wish mainly to indicate the character and value of his labours in the several departments of natural science to which the energies of his best years were devoted. As these were closely associated with the events of his domestic circle, and with the friendships of social life—as they were influenced by these, and, in their turn, influenced them at one point and another—it has seemed expedient to look at them together. Such incidents will thus serve as links by which to connect his various and influential labours as a student, as an author, and as a teacher of science.

JOHN FLEMING was born in 1785 at Kirkroads, a small farm near Bathgate, Linlithgowshire. He was the son of Mr

Alexander Fleming and of Catherine Nimmo. Both parents were noted in the neighbourhood for industry, intelligence, and Christian worth. The elder Fleming was one of a class not so numerous now in Scotland as it was forty years ago. The gradual introduction of the large farm system has greatly altered the social condition of rural districts. In the house of a working farmer, like that in which Professor Fleming passed his youth, there was much to call forth the energies of the younger members of the household. Master and servant stood much nearer each other in kindly sympathies than they do now. They sat by the same hearth, partook together of the same fare, and in field labour worked earnestly together for the common good. While this sphere had its drawbacks to a child smitten with a love of learning, it was yet well fitted to develop energy and self-reliance. Young Fleming's disposition was marked by the outstanding moral features of both parents. Like his father he was active, painstaking, persevering, industrious, and, it must be added, a good deal given to sarcastic remark in his intercourse with his fellows. Like his mother he had strong religious sentiments, much decision of character, and a faithfulness to religious convictions which, as shall be seen, circumstances could not even modify. Mrs Fleming had early desired that John should be led to look forward to the Christian ministry as a profession; and as he grew up she carefully sought to give direction to his young mind. With this view he was sent to College. But even after he had spent several years in academical studies, his strong love for natural history seemed about to blight the hopes of his earnest-hearted mother. He was offered work, believed to be more in harmony than the Christian ministry with his love for science. Straitened circumstances also, brought about by his father's loss of means from the failure of a local private bank, made him anxious to engage at once in remunerative labour. His mother interfered. When alone with him one day, she handed to him her pocket bible, told him to go out to the hill side and read the verses she had marked. The Word which was her counsellor and guide became his. The passages pointed out to him had answered his thoughts, and their careful perusal decided his choice of a profession. But her joy was not unmixed, for in choosing, he resolved to leave the Dissenting denomination to which she was zealously attached, and to enter the Divinity Hall of the Established Church. She accepted the choice, however, but long continued to hope that John might be won back again to "The Testifying Body," as the *Old Light Dissenters* loved to be characterised.

At the age of seventeen, Mr Fleming attended, as an enthusiastic student, the class of chemistry and pharmacy in the Edinburgh University. At that time Professor Hope was in the prime of life. Gracefully, yet vigorously, as a lecturer able to keep alive that intense interest with which his greatly distinguished and original-minded predecessor, Dr Black, had invested his favourite science. A year before, Dr Chalmers had attended the same class, for the gratification of those strong scientific tastes which attracted him to Fleming in after years, and led to a life-long friendship. To a mind like Mr Fleming's, Edinburgh at that time presented peculiar attractions. Black's discoveries and his methods of chemical research were fresh in the minds of students. Robison taught with profound ability and with great success the class of natural philosophy. The two Thomsons were throwing into their lectures on chemistry the fascinations of the new method. Hope was attracting hundreds of young men to his class-room. Hutton's "Theory of the Earth"* had been seventeen years before the public, and was becoming more fruitful than it had yet been in interesting the minds of geologists, and in leading to discussions, every one of which forwarded physical truth. And Stewart, who was very much to moral philosophy what Hope was to chemistry, both being the graceful interpreters of the profound systems of their great masters, was with easy grace beguiling many thoughtful young minds over to a thorough affection for the Scottish philosophy.

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* The first part of the "Theory" was read to the Royal Society by Dr Black, on the year of Fleming's birth, 1785; and from F. it received its earliest and hardest hits in "The Wernerian."

The studies and associations of 1802 influenced him through life. A careful perusal of the sections* in "The Philosophy of Zoology," devoted to "Elementary Substances," and to "Compounds of Organization," or of the chapters in which he treats of "Organs of Perception," and "Faculties of the Mind," will shew the impressions which the pursuits of this period, and the professors under whom he studied, had made upon him. As many, likewise, as waited on his lectures when he became a teacher of natural science, will remember how much importance he attached to a knowledge of chemistry, as a basis for the successful study of mineralogy, and how skilful he was in its application, when dealing with chemical mineralogy, and when discussing the characteristics of organic masses, and of mineral species.†

Those who are rightly in the habit of tracing the partial alienation of Scottish thinkers from the field of metaphysical speculation, and their direction into that of physical research, to the influence of the Royal Society of Edinburgh, at the time to which we now refer, will not fail to notice the benefit which resulted to Christian thought, and generally to the interests of the church, that men like Chalmers, and Fleming, and Brewster were raised up to stand in the midst of those whose discoveries led to speculations of a peculiarly delicate and difficult kind. The revival of science in Scotland acted in two ways. On the one hand, it laid a grasp like that of a giant on the thoughtful youth of the period, and at one point and another suggested the possibility of the inauguration of scientific, as opposed to revealed, truth. On the other hand, it begot in the minds of many good, but not very well informed, churchmen, the notion, that science was antagonistic to Christianity, and should be discouraged as leading to scepticism. What was needed in order to check the tendency which had already set in, to separate the highest minds of the country from the church, was the presence in her membership of men of thorough scientific attainments—men of whose true Christian principle she did not stand in doubt. These acted as links of sympathy between her and the students of nature. Thus suspicion of science was kept under, and the notion, that its successful prosecution implied the drifting away from a child-like acceptance of the doctrines of the cross of Christ, was effectually checked. This was the position which Chalmers assumed with such important results. It was this, too, which Fleming occupied with marked success ; and it is not too much to aver that this has been the attitude of Brewster for nearly half a century.*

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* Vol. I. pp. 54–80 and 164–307.

† See "Institutes of Natural Science," for the outline of his lectures on *Synthology* and *Mineralogy*.

Endowed with a taste for natural history, Mr Fleming's native district supplied opportunities specially favourable to its exercise and gratification. From early youth he studied Zoology, Botany, and Geology, after a fashion which always leads to success. Having acquired the general nomenclature of a science, he applied it in the field, in the identification of the objects around him. Thus we find him, when almost a boy, marking the geological features of the district, both from surface characteristics and from sections of strata made in mining or in quarrying operations. He carefully catalogued every native plant, and, with rod or gun, brought many of its rarer animals under examination. Taking the Kirkroads cottages as a centre, and limiting the view to the radius of a mile, at least three varieties of fossiliferous limestone occur, and, associated with them, phenomena of trap action peculiarly interesting. The botanical riches of the neighbourhood were pointed out by Mr Fleming himself in the "Outline of the Flora of Linlithgowshire,"† and several important additions can now be made to that list. The frequent references in the "British Animals," to localities in his native county, shew that it had supplied him with many specimens in his zoological studies. He had hoped to do for the place of his birth what White has done for Selborne, but was hindered. In the conclusion of the

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* See Chalmers' Life, vol. i. p. 386 : British Animals, p. xviii ; and North British Review, vol. iv. p. 386.

† Read to the Wernerian Society, 1809.

MSS. Botany of Linlithgowshire, he writes, "During the time I resided in West Lothian I endeavoured to collect all the information regarding its natural history in my power. If I had resided longer within its bounds, I intended to have written a complete description of that county. Being now removed to a distance, all hope of accomplishing this is at an end. I shall, therefore, at a future period, communicate to the Society such observations on its zoology and mineralogy as appear calculated to elucidate, in any degree, the natural history of Scotland." The proceedings of "The Wernerian" shew that he fully kept his promise.

Having been licensed as a preacher in connection with the Church of Scotland, he was soon after ordained over the congregation at Bressay, in Shetland. The circumstances connected with his presentation to Bressay, are worthy of notice. So early as 1807, his accomplishments as a mineralogist had attracted the attention of Sir John Sinclair, well known from the enthusiastic interest he took in the progress of Scottish agriculture towards the close of the last, and at the beginning of the present, century. Sir John asked Mr Fleming to undertake a survey of the economical mineralogy of the northern isles. In the spring of 1808, Mr Fleming wrote to Sir John from his brother's farm, Capithall, near Bathgate, and asked introductions to the parish ministers and others. "I must," he said, "traverse the unfrequented glens, coasts, and islands, where I can receive no assistance from the inhabitants. I would esteem your private letters, together with others from my friends, as perfectly sufficient to procure me attention and hospitality." While engaged in this work, it fell to the Presbytery of Lerwick to present to the parish of Bressay, Lord Dundas, the patron, having failed to do so within the time allowed by law. Mr Fleming had so won the regards of the members of Presbytery, that they unanimously resolved to offer the living to him. He accepted the presentation only on condition that the people would call him after they had heard him preach. Meanwhile Lord Dundas had promised the living to another man, and now he asked Mr Fleming to resign in his favour. This he refused to do, on the ground that it would be uncourteous both to the Presbytery and the people. The patron seemed to be won by the manly frankness and decision of the young minister. He became his firm friend, and was ever afterwards ready to promote his interests.

The fruit of the appointment by the Scottish Board of Agriculture, at the instance of Sir John Sinclair, was the very able report which Mr Fleming drew up, on "*The Economical Mineralogy of the Orkney and Zetland Islands.*" When this report was published, the author was only in the twenty-third year of his age; yet there are evidences in it of great descriptive power, readiness in the application of the nomenclature of the science, correctness of eye, and such a quick appreciation of the economical value of the rocks described, as would not discredit the ablest mineralogist at the present time. The report is dated from the *Manse of Bressay.* He had thus taken the scientific tastes and studies of his youth with him into his island manse, and had laid them along side of his desires and labours for the spiritual good of the people over whom he had been set. Was this union right or even expedient? Had he, or has any minister, time for both sorts of work? Is it possible that they can meet in harmony in any one man? Fleming, like Chalmers, often found many ready to return a decided negative to such queries. It would be beside my purpose in this sketch to enter fully into this matter, but, as the report now referred to raises the question, it claims attention for a little. There is no need here of falling back on the smallness of his congregation as an excuse for devotion to scientific pursuits, because when his congregation was greatly larger, he was equally earnest in his favourite studies. Beyond doubt it is the duty of the New Testament minister to be equal to his day, and intelligently able to watch over phases of thought characteristic of his generation, in order to direct these for the glory of Him whom he is specially set to serve. And if God shall give him talents and opportunities to lead rather than to follow, in such circumstances his duty is equally clear. The ἐν τούτοις ἴσθι of the Apostle was never intended to limit the minister's study to theology. It has a broader and nobler meaning. "Identify your life with them,"—bring, then, all your gifts, all your attainments into His service: you will not less earnestly seek the good of souls, in meeting much with the thoughts of the Creator in his works, because He who created all things is the Redeemer himself. "Grace," says Vinet finely, "has not made nature an outcast." Yea, rightly received, it teaches man that the Saviour and the Creator are one. Sympathy with this view will fit for tracing and exhibiting the thoughts of Christ in His works, not less than rejoicing in His affections revealed in His word. And the Christian student will find fully as many occasions in scientific pursuits, for the cry "*domine da lucem*," as he will do in exegetical studies. It is no doubt true, that much time *must* be spent in order to excellence in any one department of science, and especially in order to such a knowledge of several branches as Mr Fleming possessed,—a knowledge by which the student can point out where branch meets branch, while the boundary line continues, and thus is able to enunciate those grand generalizations which become influential, not on the multitude only, but on great thinkers also. Few clergymen work as hard as fully employed lawyers, physicians, or merchants. There is among them a great deal of trifling at study,—a great deal of reading which takes up much time and bears little fruit,—not a little time spent in mere coterie talk. If any man be willing to eschew this, and to parcel out his day according to the claims of his position, he may manage a congregation of a thousand people, visit them once a year, attend assiduously to the sick and sorrowful, and yet find time for working in some branch of literature or science. But Scotland is so well supplied with churches that John Knox's average of a thousand people, for the care of one man, is very seldom possible except in large towns. If a man give, generally, his forenoons to theological study and preparation for Sabbath, his afternoons to visitation, and one evening, or even two, in the week to a meeting for congregational prayer, or for a Bible class, he would yet have, at the very least, four evenings, from six to eleven, for non-theological study. Who has tried to devote these twenty hours weekly to work, towards which natural tastes have drawn him, without finding that he could overtake much? The fact is, that men who cry out about neglect of duty in such cases, are either too ignorant to be able to sympathise with higher studies than catering for a Sabbath sermon, or too lazy to keep abreast of the intelligence of their day. They shelter their ignorance, their indolence, or their envy under a loud profession of zeal for what they call "a minister's proper work."

Mr Fleming's "banishment to Shetland," as he called his settlement in Bressay, was not without its advantages. Fresh opportunities frequently occurred for the application of his talents as a naturalist; and these were readily embraced. On the same month on which the mineralogical report was published he communicated a paper to the Wernerian Society, "*On the Narwal or Sea Unicorn.*" The notice is illustrated by drawings by himself, and contains a very clear description of its general appearance and structure. It was forwarded in MSS. to Sir Joseph Banks, who favoured him with the following letter:—

> "I am much obliged to you for the intelligent account of the Narwhale, lately thrown upon your coast, which I have received in due course. I agree with you in thinking it the same species as that described by Le Cepede, whose information was wholly derived from me. When he was about to finish his book, he wrote to me for assistance, and I readily furnished him with such unpublished information as happened to be in my possession; but he, like a true Frenchman, gave himself little trouble to understand what was written under the drawing of the narwhale, which stated it to have been taken at Frieston, a village near Boston,* in Lincolnshire. The animal, when found, had buried the whole of its body in the mud of which the beach there is composed, and seemed safely and securely waiting the return of the tide. A fisherman going to his boat saw the horn, which was not covered up, and trying to pull it out of the mud, raised the animal, who stirred himself hastily to secure his horn from the attack. From these circumstances, I am led to believe that he was much at his ease in the place he was in, and well able, though probably a native of more northern regions, to live in our seas. The additional infor-

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* Le Cepede describes the specimen sent by Sir Joseph Banks as having been taken at Boston, America!

mation of your letter enables us to feel safe in concluding the animal as belonging to the British Islands, and entering it in our catalogues accordingly."

At the close of the same year Mr Fleming sent to the "Wernerian" several papers entitled "*Contributions to the British Fauna.*" In these he describes distinctly for the first time, as natives of Britain, the Water Shrew (*Sorex fodiens*)—the Top-knot Turbot (*Pleuronectes punctatus; Rhombus punctatus* of Cuvier)—the Fascicle Barnacle (*Lepus fascicularis*)—the Skate Leech (*Hirudo verrucosa*)*—Echinus (*miliaris*)—and the Zoophytes—*Lucernaria fascicularis*—*Caryophyllia Cyathus*, *Fungia turbinata*, and *Flustra Ellisii*.

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* Not, however, as he thought, distinct from *Hirudo muricata* of Linnæus.

CHAPTER II. 1810 to 1820.

Flisk—Lectures on Chemistry—Habit of the Eye—Mineralogy of St Andrews —Marriage—An Help-meet—Honours—Patrick Neill—Mineralogy of the Redhead—Mr Sowerby—Ure's History—Cork Institution Lectureship—Trap and Old Red Sandstone—Paper for the Royal Society—Work in 1819—Ichthyology—Dr Barclay.

IN 1810, Mr Fleming exchanged the remote living of Bressay for one nearer the centre of reviving ecclesiastical life, of thought, and of scientific study. On the presentation of Lord Dundas he was translated to Flisk, Fifeshire, a parish bordering on Kilmany, where Dr Chalmers was at that time minister. Under date Sept. 1810, Chalmers wrote in his diary:—"Walked to Monzie. At dinner we had Mr Fleming, presentee to Flisk; accomplished in some interesting branches of science, and promises to be a great acquisition to me, from the congeniality of some of our pursuits." Again,—"Had a long walk with Mr Fleming, and am happy to find that he expresses a high sense of duty on the subject of the clerical office."

He now set himself very earnestly, as occasion offered, to carry out the views which, at an early period, he had formed, of what should be his work in natural science. Like John Ray, he studied the works of the Creator to discover "The wisdom of God in Creation." But he knew that, in order to become a successful expounder of the thoughts of God in creation, the highest scientific attainments were needful. Only thus could he speak with authority. What ambition so noble as to seek to illustrate, in the life and experience of one man, the perfect harmony between profound and original knowledge in science, and simple faith in God as a covenant God—between the highest efforts of reason in the study, classification, and interpretation of nature, and love for the person of Jesus Christ, revealed to us in the Bible? It is not indeed held that no other motives influenced him in his work. He sought

"In brave poursuitt of honorable deed"

to make himself a name among his fellows. He loved science, and was not a little under the power of a lawful ambition to be noted as an eminent and successful student of it.

The ways by which these views could then, as now, be realised, were two, namely, the Press, and public Lectures. To both he had recourse when settled in Flisk. His contributions to public journals and to learned societies became frequent; and, in 1811, he issued a pamphlet of sixteen pages, containing very full outlines of a course of lectures, to be delivered in Cupar, on *Chemistry and Natural History.* In a prefatory note he says :—

"In this course of Lectures it is proposed to explain the doctrines of Chemistry by a series of experiments, to point out its useful application to the arts, the manufactures, and the purposes of common life; and to convey a general knowledge of Natural History, illustrating the doctrines of Mineralogy, Botany, and Zoology by an exhibition of specimens." In the outline of the first lecture, he makes a distinction between *Natural History* and *Natural Science*, and under Chemistry he jots down—"It is a science highly useful and important, as it explains many of the Phenomena of Nature—illustrates the Principles of a number of the Arts—contributes to the comfort of Life—augments our Power over Material Objects—and affords a striking display of the Wisdom and Goodness of the Great First Cause."

This outline is not only interesting, as shewing the wide range of subjects on which he had long meditated, but as forming the basis of his first great work, "*The Philosophy of Zoology.*" It shews, too, what good use he had made of his opportunities for observing nature. He let no occasion slip of adding to his own information, or to that of those who, at a distance from him, were earnestly at work in the same pursuits. A fish, not before known to frequent our shores, is accidentally entangled in the nets of the northern fishermen, and forthwith he makes a drawing of it, and forwards a description of its form and structure to the Wernerian Society. A new Zoophyte is found in the refuse of the Zetlander's trawl; a bird, not before observed in Scotland, crosses his path; a flower, undescribed by Lightfoot or by Smith, is noticed by the wayside or in the wood ; these are accepted as prizes, correctly described, a place assigned to them in the generalizations of science, and are forwarded to his friends—the fish to Neill or Jameson—the Zoophyte to Leach—the bird to Montagu—the plant to Don. A good illustration of this habit of the eye occurs in a letter to Professor Jameson, (1812). While walking, to fulfil a ministerial engagement, along the shore of the Tay from Invergowerie eastward to Dundee, he was struck with the look of the rocks, the relative position of the sandstone to the porphyry, &c., and straightway he transmitted to the professor a sketch of their appearances, with specimens to illustrate their mineral characteristics. Soon after he is led, in the same way, to give his attention to "*The Rocks in the neighbourhood of St Andrews.*" The Wernerian was again the channel through which his observations were made known to contemporary geologists. The paper on the rocks of St Andrews contains several of those somewhat bitter *hits* which he was ever in the habit of dealing at the grand speculations, as he called them, "whose bases eluded even a very powerful lens." It was in this contribution also that he drew the attention of geologists for the first time to the well known "Rock and Spindle." His views of it are substantially the same as those afterwards given by Sir Charles Lyell.[*] His references to Hutton are worth quoting,—

> "In this place, he says, I may take the liberty of observing that the closet mineralogist may indulge in hypothetical speculations regarding the formation of minerals ; but such conjectures will never aid the cause of science, or make us acquainted with the secrets of nature.[†] I have no doubt but that Dr Hutton, upon examining a specimen of the Septarium iron-ore, was gratified with the idea of having found a convincing proof of the igneous consolidation of fossils, and regarded his explanation of the singular structure of that mineral as the only one which approached the truth. But we hesitate not to say that, had that ingenious philosopher ever attended to the natural history of the Septarium,—had he ever examined it in its clayey bed, completely surrounded with matter which presented no marks of igneous influence,—he could not have avoided drawing

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[*] Elements, p. 433, 3d Edit. 1851.

[†] Here his jealousy of *theory* leads him to extreme views.

the conclusion that, since the bed of slate-clay, which contains the Septarium, presented no marks of the action of heat, the Septarium contained could never have been exposed to its influence." Again—"If the regular form of the basalt induced Dr Hutton to conclude that they furnished proofs of the action of a central heat,* he would have found considerable difficulty in applying his heat to those inclosed masses of basalt, without fusing the bed of tuff which surrounds them. He who has the boldness to build a theory of the earth, without a knowledge of the natural history of rocks, will daily meet with facts to puzzle and mortify him."

About a month after his paper on "The Mineralogy of St Andrews" was read to the Wernerian, Mr Fleming was married (March 1813) to Miss Melville Christie, second daughter of Andrew Christie, Esq., banker, Cupar. In Miss Christie he had found one of kindred tastes, one who became an help-meet not only in the domestic circle, but in ministerial work and in scientific studies. The valuable aid rendered to him by Mrs Fleming in his favourite science, is acknowledged in the Preface to the Philosophy of Zoology. "The plates which have been added to the present work, consist of figures relating exclusively to British animals. They are not gaudy, but they are correct delineations from nature, for which the writer is indebted to the pencil of his wife." This, however, is saying too little in reference to these illustrations. They exhibit true artistic taste, correctness of eye, and ready skill of hand.†

Mr Fleming's mineralogical papers, and his contributions in natural history to the Proceedings of the Wernerian Society, had made him well known to the leading minds of his native country. He was already a member of the Antiquarian Society—in 1813 the University of St Andrews conferred upon him the degree of D.D.; and in January 1814, he was elected a Fellow of the Royal Society of Edinburgh. At that time a recommendation by three members was needed. In Dr Fleming's case the recommendation was signed by three even then famous—Professors Jameson and Playfair, and Dr, now Sir David Brewster. This Society, of which he continued a distinguished member till his death, and whose Proceedings are enriched by several of his original papers, has had, and continues to have, a beneficial influence on the promotion of Scottish literature and science. On its *rôle* stand the names of most of the Scotchmen who have distinguished themselves in either of the departments with the literature of which it has mainly to do.* The meeting that chose Dr Fleming also elected Mr Patrick Neill, on the recommendation of Sir George Mackenzie, Professor Dugald Stewart, Professor Jameson, and Alexander Keith, Esq. Patrick Neill, "printer and philosopher," had long been an intimate friend of Dr Fleming, and continued to be so till his death. He was an able, enthusiastic, devoted, and successful naturalist, and ever cherished a profound admiration for all whom he regarded as true students of natural history. His voluminous correspondence with Dr Fleming is characterised by strong good sense, geniality, frankness, humour, and, withal, such a taste for literary and scientific gossip, as makes his letters graphic pictures of the circles in which he moved. They give us sunny glimpses, too, into his garden at Canonmills. We seem to see his quaint-looking figure watching there his zoological favourites for the time, experimenting in new methods of grafting and budding, or carefully bending over the rare wildflower which his friend Fleming had picked up a few months before in his wanderings about Flisk. Or, after a meeting of the Royal Society, he might be seen in his happiest mood at his own table, for Jameson, and Brewster, and Allan, had walked home with him. The tie between him and Fleming, as revealed in their correspondence, was peculiarly beautiful. Having the highest estimate of his friend's talents, he seemed to live for years mainly seeking to give them direction. Living in the capital, he kept the young minister of Flisk acquainted with everything of interest in natural history. Every bit of scientific gossip was duly chronicled, all the coterie jealousies were described, the opinions held by men of science regarding the last contribution from Flisk, were set down, and the freshest information in science gathered up for behoof of his beloved friend Fleming. He was the first to intimate his election as F.R.S.E., and Dr F. wrote: "Many thanks for letting me know the honours I have obtained. I have got even more than I deserve. I am going to the Presbytery just now, and expect a good deal of quizzing." Neill fully appreciated his ability, and seemed resolved to keep him at work. Letter after letter urged him to exertion in one department and another, as if the worthy printer felt that in his friend's successes he himself triumphed. And he did not urge in vain. Numerous notes reached him from the Fife Manse reporting progress :—

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* He ever regarded with suspicion the cut and dry explanation of what *must* be at the centre of the earth. Long after this, when, during one of his excursions with his New College students, he had passed from the "terrible" boulder-clay, to tell of the order of underlying strata, his thoughts were broken in upon, during a pause in the conversation, by a young ecclesiastical hopeful, who abruptly asked, "But, Doctor, what is at the centre of all?" "I don't know, sir," the Professor answered dryly, "*for I was never there!*"

† See, for example, Plate II. and Plate III., Fig. 2d. The great artistic talents exhibited in these are far more fully shewn in other works which I have been permitted to examine. Dr Fleming had greatly desired a copy of Müller's magnificent *Zoologia Danica* and his *Entomostraca*. The works, however, were too expensive for his means at that time. They were borrowed, and Mrs Fleming copied not only every word of the text, but all the engravings also, and this in such a style of drawing and colouring as to surpass the original.

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* *Royal Society*:—Formed 1731, as the Medical Society, and presided over by Dr Alexander Monro. At the request of Professor Maclaurin and others, enlarged as the Philosophical Society of Edinburgh, 1739. Its meetings, interrupted by the national political troubles, were resumed after them, Dr Alex. Monro (secundus) and David Hume, Secretaries. At the request of Principal Robertson it was put on a broader basis still, and in 1782 was constituted under Royal Charter "The Royal Society of Edinburgh." At its first meetings, Black, Hutton, Playfair, Walker, Robison, Gregory, Dugald Stewart, &c., took an active part. When Dr Fleming was elected, the eminent mineralogist Sir James Hall was President; Professor Playfair, Secretary; and Thomas Allan, one of the ablest mineralogists of his day, Keeper of the Museum. Allan's paper, read in 1811, on "The Rocks in the Vicinity of Edinburgh," may even yet be studied with profit.

"1819. I have been expecting a proof of the last part of the *Rail* paper. Fearing you may have too much spare room in the journal, I send you a paper for insertion this month. By doing so the Professor and Dr Brewster will oblige me. I have sent a review in which Dr Leach gets a few gentle hits." Again, "I have now finished my view of Instinct. I have been able to give the subject that degree of illustration which has rendered it tolerably clear to me. I say *tolerably* clear, for it is difficult to comprehend the movements of the *vital* principle or of its attribute mind. But it is practicable to get a knowledge of its conditions and varieties. I am coming slowly on with *the* book, although far from idle." "If you could spare a plate or two, I could give you for the Wernerian a paper on Scottish Animals, extending to fourteen or fifteen pages, and describing a few new species." "1814. I have this moment received another specimen of the Shad (*Clupea Alosa*), which I hasten to transmit for your examination. It is probably the first of its kind found in Scotland, for although Pennant says that the *White Bait* is found off Aberdeen, he acknowledges that he never heard of the full grown fish." Again, "I have lately been making a catalogue of the animals of Scotland, beginning with the Mammalia, and among extinct quadrupeds the Beaver is usually mentioned, but the last place it haunted is not mentioned in any book in my possession. If my memory serves me, it was in the *Ness* in Inverness-shire, and known in the Celtic by a name signifying the animal with the scaly tail. The surviving quadrupeds have been stated by Pennant at forty-five, and by Dr Walker at forty-five; now I think I know about fifty-four, besides six extinct ones." Again, "In the box which I sent to Leach there was a parcel of fossil shells for Sowerby. These have been faithfully returned. In the last number of his Mineral Conchology he has figured five of my shells under a new genus which he has formed—*Productus*, and no less than one of the species he has termed *P. Flemingii*. I could have dispensed with the compliment; it sounds horribly." "The paper on the Orthoceratites will soon be ready. I intend to send to the Wernerian the paper on the Redhead. Some parts of it will probably be considered heterodox. My ride to Alloa convinced me of the accuracy of my opinion regarding the structure of the Ochils, and enabled me to detect several errors into which Mackenzie had fallen." "1815. We seldom, I believe, give an advice to our friends without being satisfied that it will be well with ourselves. I grant you that I have often devised similar plans, and often chalked out a *magnum opus*. I will frankly tell you, mine is to be the *Zoology of Britain*, including the present race of animals, and those which have become extinct. The plan is formed, and, though vast, is undertaken in early life. To this magazine I am daily adding some fact, and ere long you will see some proof of activity."

The paper "*On the Mineralogy of the Redhead in Angusshire*," was sent to the Wernerian Society in 1815. It is one of Dr Fleming's ablest contributions to mineralogy, bearing, as it does, evidences of great talent in the description of rocks *in situ*, discussing the prevailing theories regarding the remarkable caves which are found above the present highest tide-level, specifying the different minerals found, noticing the characteristic fossils in some of the rocks, and hazarding an explanation of the mode of formation of agate balls in beds of amygdaloid. His inductions are drawn from his own observations; and everything but facts which had come under his own notice, is rigidly excluded from them. The result is, that several very difficult questions are broached in this paper, in a way which shews that his mind was already made up on them. These soon afterwards have definite expression given to them ; they pass into his scientific creed, and he clings to them through life with the same firmness as he did to purely moral convictions. The writer was much struck with this when he one day dropped in to listen to one of his New College lectures. He was speaking of the presence of reniform ironstone in clay-slate, and flint modules in chalk beds; and, acquainted with "*The Mineralogy of the Redhead,*" the thought instantly occurred, 'this is the same point of view as that indicated in 1815. More than thirty years' earnest work and observation have not revealed to him any facts to shake his confidence in the explanation offered at that time to the Wernerian.'

"The structure," he then said, "of this bed of amygdaloid, leads to the conclusion, that while a general disposition to stratification prevailed in the aqueous menstruum, there existed a number of partial spheres of aggregation. Thus, while one portion of the fluid was depositing grains of calcareous spar and quartz, and enclosing these with wacke, claystone, or felspar ; another portion was depositing basalt, clinkstone, and greenstone, together with nodules of flint, jasper, and calcedony, in the form of agate balls. . . . These facts, in the history of agate balls, prove their simultaneous formation with the rock in which they are enclosed."

But this stedfastness to old views never made him indifferent to new facts. These were welcomed by him in the spirit of a true philosopher, and were permitted to modify or even to reject cherished former views.

Reference has been made to the eminent conchologist, Sowerby, in the extracts given above from his letters to Neill. On receipt of specimens from Dr Fleming, Mr Sowerby wrote, "I feel highly gratified at your ardour and zeal, so promptly expressed by sending such *tender rarities* so far. Your kind friend, the Rev. Mr Lambert, of *Trinity College,* talked of recommending me to your favour. He has great zeal." Again—

"My Dear Sir,—It gave me much pleasure to receive, by your favour, the History of Rutherglen. I think you might add much to Ure's History. I anticipate your kind intention of sending me some rarities. When you have quite spare specimens, if ever so common, I shall be glad to have them. I don't understand the figures in Ure's book, in many respects, without specimens; his *Patella fungites*, his *cockles, fishes' teeth*, &c. If not difficult to procure, I should be pleased with some of the charred branches of trees, the varieties of hard coal, and minute shells. I will attend to your letter in all particulars. If I can send you anything, pray say how, and I will accompany them with my *Elucidation of Colours* for your acceptance, to entertain you a little. I am, Kind Sir, yours very faithfully,

"3d *March* 1815. JAS. SOWERBY.

"2 Mead Place, Lambeth, Surrey."

This letter is interesting, both because of the reference to the History of Rutherglen,* and as indicating how little progress had been made in British palæontology at the time it was written. A glance now at the rough figures given by *Ure*, is sufficient to detect the species from which his drawing had been made. David Ure's book was a special favourite of Dr Fleming. He had early found in it a breadth of view, and an accuracy of observation, in the young science, geology, which were not equalled in his native country at the time; and in his after labours, in more advanced science, he had great pleasure in referring to the work of the Scottish Church Probationer.

The revival of physical science in Britain towards the close of the last, and during the early part of the present, century, had extended its influence to Ireland. Associations were formed for its promotion in the capital, and in one or two of the large provincial towns. In Cork a society was founded, by a royal charter obtained in 1813, for providing lectures in "Natural Philosophy, Chemistry, and Natural History, including Mineralogy, and Botany, and Agriculture." The association took the name of "The Cork Institution." In 1815, its managers caused advertisements for a lecturer in natural history, to be inserted in the Edinburgh newspapers, and Dr Fleming made application. At this time he strongly entertained the thought of leaving Flisk and settling in Ireland, in order that he might betake himself to natural science, not as a leisure study, but as the business of his life. As regarded emoluments, he thought that, if permitted to add the fees that might be obtained from private classes, to the salary of £100 allowed by the managers, his income, even at the commencement of his work, could not be less than he had at Flisk, where his stipend did not average more than £150. In his letter of application and inquiry, he referred the Directors to his scientific papers already published, and added—

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* *History of Rutherglen by Rev. D. Ure.* Glasgow, 1793.

"To all these testimonials I could also add the most ample recommendations from the following gentlemen, to whom my character and pursuits are well known:—Robt. Jameson, Prof. Nat. Hist. Edin.; J. Playfair, Prof. Nat. Phil. Edin.; Dr Hope, Prof. Chem. Edin.; Dr Monro, Prof. Anat. Edin.; Dr Barclay, Lect. Anat. Edin.; Dr Murray, Lect. Chem.; and from Dr Brewster, Dr Wright, Dr Yule, and Mr Neill, Edin.; and to Dr Leach, British Museum. I have thus candidly stated to you what I conceive would be my pretensions were I to appear as a candidate for your lectureship; and although the situation be one which would be most congenial with my feelings and pursuits, I trust you will forgive me for thus appearing by my queries to temper my zeal for science with a little worldly prudence."

The answer from Mr Edmund Davy, Lecturer on Chemistry and Secretary to the Institution, was, in some respects, very favourable. Neill, however, seemed to see farther into the matter than his friend. He writes urging caution, and so puts his views as to tempt the young minister of Flisk to set his mind on something higher than the Cork lectureship.

"Without, he says, more satisfactory tidings than the Secretary's letter, I would think it rash to give up Flisk. How respectable is your station in society, and in the literary world, as you now stand. Minister of the Church of Scotland, F.R.S.E., universally considered the first Zoologist in Scotland, one of the first Geologists, your name ranked among the most distinguished writers in the Supplement to the Encyclopædia Britannica, and conveyed down to posterity along with them in Napier's preface."

In a letter, of date 20th January 1816, Dr Fleming, in answer to a communication from his friend, hinting at pecuniary loss if he should remove to Cork, compares his present income with the prospects before him, and resolves to make farther inquiries. Dismissing the lectureship, he gives the bachelor of Canonmills a somewhat tempting glimpse into the parlour at Flisk:—

"After dining with Mr Syme, I took my station at my own fireside, at six o'clock,—the room comfortable, my wife contented, and reading "Waterloo," and a favourite 'yellow yoit' (yellow hammer) ready to sleep upon my shoulder. Under such circumstances, I am in good spirits, and purpose replying to your letter, and then, if I do not forget, to several 'Annals'' matters.

"What seemed most noxious in the Annals was the quiet way in which Professor Jameson takes or gets all the merit of ascertaining the beds of trap in the Old Red Sandstone. There is something mysterious in the proceedings. When I published 'Papa Stour,' the Professor insisted that I must have committed an error in describing conglomerate as conformable with the clay stone,&c., of that island; and his reason for considering me wrong was, 'no such arrangement exists in the Wern. Geog.' My Dundee paper confirmed 'Papa Stour,' and then I got loose of trammels, odious and injurious. He knew that I considered the Ochils as a part of 'Dundee,' and older than the coalfield; and I told him that the range of hills from Dundee to Perth were Old Red Sandstone! Nay, after I was at the Redhead, I visited Kinnoul Hill (the day you went to Forfar) and saw the regular succession from the base to the top. Nay more, I expressly told him (upon my return from Arbroath), that Dunbar was not what he suspected, but that it belonged to the Old Red Sandstone, and that between Traprain Law and Sunnyside he would find beds of Clinkstone Por. alternating with the limestone of that district. Jameson visited Dunbar, changed his faith, and gave the W. Society a paper, the contents of which were carefully published; while my Redhead paper was scarcely noticed, except my account of the gravel beds. I was advised to reserve it for the Wern. Mem., and in the mean time the boldest assertions which it contains have been verified without any notice, public or private. To Jameson I feel all the deference due to a great master of the science, but still let justice be done. Now, taking all circumstances in connection, I do consider that there is something mysterious in all this, and begin to suspect that I must either publish my observations when made, or serve as a step of the stair to those who consider not upon what they are trampling."

Dr Fleming intimated to the managers of the Cork Institution his willingness to take one course of lectures, and resolved to take Neill's advice to "see things with his own eyes before he determined on a permanent settlement." He was unanimously elected over several other candidates, and delivered a course of eighteen lectures on Botany in the spring of 1816. His Presbytery, with great kindness and ready liberality, not only granted him leave of absence for three months, but took upon themselves the supply of his pulpit. The lectures were most successful. His visit to Ireland led him, greatly to the regret of a number of friends he had made in Cork, but much to the delight of Neill, to give up the intention which he had once entertained of making Ireland the place of his abode. While there his mind had not been engrossed with the lectures; for on returning, he drew up and published an interesting outline of "*Observations on the Mineralogy of the neighbourhood of Cork.*" This paper is characterised by evidences of the same powers as have been noted in connection with his mineralogical survey of the northern isles,—discrimination, readiness in the application of nomenclature, and an appreciation of the value of marking the relation in which different series of strata lie to each other.

After he returned from Ireland, he drew up and read the first paper contributed by him to the Royal Society. It is entitled, "Observations on the Junction of the fresh water of Rivers and the salt water of the Sea." The subject had long engrossed his attention. Three years before he had described the mode of observation, and indicated what he thought might be the value of it in relation to the existence of shore plants, &c. at a much greater distance from the sea, than existing views of the reach of the tide would have warranted to expect. But though this paper is both interesting and ingenious, it is clear that he regarded it very much as given for the sake of appearance, having been so long a fellow without having made any addition to the Society's proceedings. Indeed, at this period he had not time for any literary work which did not yield immediate pecuniary advantage. For several years he had been able to add something to his small income as a parish minister, by his labours in the literature of his favourite sciences. The following letters to Neill give us a view of his work in 1819:—

> "I am still very busy, but, alas! the progress is slow, the subject extensive, and in order to do it justice, I would require the private use of the whole Parisian collection of Comparative Anatomy.
>
> "You say you are still overwhelmed with the cares of this life, yet, strange to tell, you are studying Italian for amusement! Rather prepare a course of lectures on Horticulture, or the Physiology of Plants. The new garden will require a lecturer!!

"I have seen the first number of the new Review. The articles appear in general to be written by young hands. There is rather a feebleness of style. At the same time there is a distinct account given of the contents of each book. In the review of Birkbek, for example, the views and true character of that author are infinitely better exposed than in the Edinburgh Review, even independent of the peculiar political bearings of the latter.

"My situation excludes the hope of ever being a traveller. It is my intention to collect facts patiently, to read nature more than books, and trust to Providence more than to politicians.

"Mrs F. joins in warmest regards.—Yours ever, "JOHN FLEMING."

"*19th Nov.* 1819.

"My Dear Sir,—When I had finished looking over the Sertularia papers, another packet arrived, and I now give a general reply to the whole.

"I was glad to see the last paper, as enabling to correct a mistake into which I had fallen in consequence of relying on the general accuracy of Mr Templeton.

"I have no objections to the insertion of the Rail in the Memoirs, according to the wishes of Prof. Jameson. It was originally sent to fill up a blank rather than to gratify a desire for having it published; and although ten guineas a sheet is an object, in a year like this, when the stipend will scarcely exceed £150, I am not so intent upon cash as to regret that it goes to support the Society, even should its profits fatten the bookseller only. . . . Waugh has taken care to supply me with food, having sent Greenough's book (far from good), the 12 vol. Linn. Trans., and Samouelle's Entomology, a despicable performance, and Scoresby's work likewise falls into my hands when published. . . .

"Many thanks for Montagu's paper. I thought he had communicated a fig. of the head and teeth—but there is no reference. For shame if you have begrudged him a plate! If you are in possession of his drawing, I should like to have an opportunity of copying it.

"Young Alex., the son of your friend, came into this world on the 3d of July, and in the notice it is the 4th. It will disturb no one but his biographer, should he deserve one.

"Who is the author of 'Sandstone Petrifactions'—a partizan obviously of crystalline deposits. But such crystallizations are nearly as unintelligible as a central fire without fuel and air—they exist only in the imagination, not in our *experience.* It would be easy to cut up this theory by the roots; indeed, its only prop has been destroyed by an observation in my Cork paper. *Petrified shells* gradually pass into the matter of the surrounding rock, *therefore* they cannot be fragments, but contemporaneously formed figured masses, if this test can be relied on,—a conclusion which this theorist would scarcely venture to draw. Yet, either the test must be relinquished and its dependencies, or this absurdity received.

[illegible] and I hope his friend will soon [illegible]

[illegible] he showed me a piece of charred [illegible] bed of marl, and about which [illegible] The wood has been charred, [illegible] as its appearance [illegible]

[illegible] on *Hybernation* for Mr Scoresby, [illegible] established with regard to the [illegible] a subject on which he [illegible]

[illegible] on the change of colour [illegible] being aware that I had [illegible] and investigated the laws [illegible]

[illegible] "John Fleming."

[illegible] completed the important [illegible] *Encyclopædia*. Among [illegible] which were given at the [illegible] the impartial criticism of [illegible] lecturer on anatomy, [illegible] anatomist of this or any [illegible] back with gratitude. [illegible] the following communi-[illegible] "Life and Organization"* [illegible] of the man, and the [illegible] of the "Laird of Canon-[illegible]

"[illegible] Square, May 2. 1819.

[illegible] with much plea-[illegible] the subject admits of it, I [illegible] with your plan, it [illegible] pains on the execution. [illegible] with which they are familiar, [illegible] know more than can reasonably be ex-[illegible] their studies. In the first chapter we are [illegible] views, before we are fully instructed in the principles of any one arrangement. Rather astonish us at first with the immense variety of these animals; then mention the attempts at arrangement; on what views these attempts were made; give us one complete arrangement as a standard of comparison, and then the synoptical views in their order. In anatomy, you use the word cranium for the head, and say it is large in proportion to the size of the body. Now the cranium is small for the size of the body, but the head, which includes the bones of the face, remarkably large. The bones of the vertebræ are formed of cartilaginous rings, but contain a fluid not a cartilaginous substance. In page 667 you call the transverse processes spinous, but the spinous processes on ribs are attached. You speak of bones unconnected with the skeleton; it would have been better to have said that many bones of the skeleton are connected only through the medium of soft parts, as the upper extremities in many quadrupeds are connected with the trunk. All bones in fish are not softer than in the mammalia. The bones of the ear are, in some fishes, as hard as any bones in the mammalia. The spinal marrow is conveyed in fishes, in the same way as in quadrupeds and birds, on the dorsal aspect of the vertebræ and in the bifurcation of the spinous processes; but the spinous processes are not inclined, and they stand at a distance, so that the spinal marrow can easily be seen through the large intermediate spaces. Your terms, superior and inferior, posterior and anterior, have sometimes a reference to the back and breast, and sometimes to the head and tail. If you adopt not my nomenclature, at least use terms of a definite meaning. The meaning which you put into ambiguous terms will not always be the meaning that is taken out of them. I was expecting to have seen you in Edinburgh this week, and was congratulating myself on the pleasure of a long conversation upon these subjects. Cuvier came quite safe; and I am, with best respects to Mrs Fleming, my dear Sir, yours with esteem, and most sincerely, "JOHN BARCLAY."

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* [illegible] a valuable work, is given in a con-[illegible] Wernerian, Dec. 1815, on "Causes of Organiza-[illegible]"

"My Dear Sir,—The Doctor having written his sentiments at my request, handed me the letter, open. Let me know whether you possess Barclay's 'Anatomical Nomenclature.' If not, it shall be at Flisk next week. I stated to the Doctor that your only objection would probably be to the *adverbs*, which are not constructed according to the English analogy; —dorsad, sternad, &c. Prof. Jameson read your paper, and shewed the specimens. In concluding, he made some remarks, first praising, and then expressing a hope that you would *extend* the paper before publication, and also try to give specimens of some of the minerals and petrifactions not sent. Mohs * and Brewster were there. Mohs spoke to me of you, and regretted he saw so little of you. Both of them, with Jameson, Allan, &c., came to Canonmills to dine. "PAT. NEILL."

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* Frederick Mohs, Professor of Mineralogy at Freyburgh, known to mineralogists by his "*System of Crystallography*," an able review of which, from the pen of Sir David Brewster, appeared in 1821. See Wernerian Transactions, vol. iii., "On the Primitive forms of Rocks;" and for a paper by Mohs,

The enumeration, in the introductory remarks, of the mode of treatment to be followed, shews that he had attained to a point of view in advance of most naturalists. He resolved to deal with his subject in such a way as that, while systematic arrangement and strictly defined specific characteristics should be kept in view, he would give heed to structural peculiarities, to habits as far as they could be ascertained, and to the economic value of different species. In reviewing the History of Ichthyology, he gives the names of twenty-four authors whose works he had consulted, and of eighteen whose proposed systems he had examined. The writer has looked into several of the least accessible of these, and he finds that the outline given by Dr Fleming bears evidence that he had well studied the original works. These works range from 1533 and 1555, in which years respectively, *Belon* published his "*De Aquatilibus,*" and "*La Nature et Diversité des Poissons avec leurs Portraits,*" up to 1803–4, when the Ichthyological part of *Shaw's* "*General Zoology*" was given to the public. In the survey he deals carefully and critically with the systems of *Willoughby* and *Ray, Dale, Artedi, Klein, Linnæus, Gronovious, Brunich, Cuvier, Lacepede,* &c. His notices of writers on British Ichthyology are equally numerous and discriminating. They range from *Merret's* "*Pinax Rerum Naturalium Britannicarum,*" 1667, to *Low's* "*Fauna Orcadensis,*" 1813. Among others, he notices *Donovan,* and his friends *Turton, Montagu,* and *Patrick Neill.** The chapters on "Structure and Functions," and on the "Condition of Fishes," may be read by the young Ichthyologist with profit, even now when this branch of science has come to be associated with so many more great names than even those quoted above.†

"General Reflections on various important subjects in Mineralogy," Edin. Phil. Jour., vol. xiii., 1825.

* *Neill's* "List of Fishes found in the Firth of Forth, and Rivers and Lakes near Edinburgh," was read to the Wernerian, and is printed in vol. i. of the Transactions.

† Prof. Owen, Milne Edwards, Agassiz, the Prince de Canino, Yarrel, &c.

CHAPTER III. 1820 to 1829.

Hydrozoa — Beroë — Hirudines — Scisssurella — Insecta — Helminthology — Voyage in 1821—Submarine Forests—Philosophy of Zoology—Letters from Curier, Barclay, Turton, &c.—Separate Papers—Distribution of British Animals — Modern Strata — The Deluge — Dr Buckland — Sir William Hooker—Professor Jameson—History of British Animals—Antiquarian Pursuits—Tombden Wares—The Old Red—Hugh Miller—Dr Anderson's Mistakes—Climate of the Arctic Regions—Rev. W. Conybeare—Pig's Foot Controversy—Dr Mantel—The Wheat-Fly.

HAVING finished Ichthyology, Dr Fleming set himself earnestly to work in Natural History. He had, for a good while, been giving much attention to the general views, which were soon afterwards matured and embodied in "*The Philosophy of Zoology.*" His correspondence at this time also bears evidence that he was rapidly accumulating those stores of knowledge, which were to find a place, as illustrative facts, bases for induction, and authoritative references, in "*The British Animals.*" In 1820, he was labouring successfully among the Hydrozoa. To the Wernerian, he sent the description of "a species of the genus *Beroë*,* which had not hitherto found a place in "British Zoology." In the same communication, he told the Society that he had found in the neighbourhood of Flisk, two leeches, also new, *Hirudo tesselata* and *H. lineata.* Soon after, he communicated "Observations on some species of the genus *Vermiculum* of Montagu,"† and described four new species. To the same Society he made known his discovery of the pretty *Scissurella crispata*,‡ which continues to be associated with his name, in recent works on Systematic Conchology. The circumstances connected with this discovery, well illustrate his shrewdness as an observer. So early as sides, in favour of worms, it should be hinted that green corn, plants, and flowers, are not so much injured by them as by many species of insects in their larva or grub-state, and by unnoticed myriads of those small shell-less snails called slugs, which silently and imperceptibly make amazing havoc in the field and garden."

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* ACALEPHA. Ord. *Ctenophora*—Fam. *Beroidæ*.

† Now described under *Serpuladæ*.

‡ Family, *Haliotidæ*.

It in no way detracts from the ability shewn in this article, to say that it might *now* be greatly improved. In some points, it is at fault, as in the explanation of the motion of the earth-worm, and in others, as in the habits of the same creature, it might be largely supplemented. While working in such channels, he was not unmindful either of the unremunerative Wernerian, or the remunerative Edin. Phil. Journal. To the Proceedings of the former, he communicated "*Dewlike Drops on Leaves of Corn,*" "*The Water Rail,*" "*Sertularia,*" "New species of *Vorticella,*"* &c., and to the latter, "*The Arctic and Skua Gulls,*" "*Sertularia gelatinosa,*" "*Changes of Colour in the Feathers of Birds,*" &c. In 1821, a favourable opportunity occurred of acquainting himself with the west coast of Scotland, and of obtaining some relaxation from the severe mental labour connected with the preparation of his first great work. He was invited by his intimate friend, Robert Stevenson, Esq., to cruise with him along the west coast, in the Government Lighthouse Yacht. They put in for a few days at Campbelton, and the worthy magistrates paid them the compliment of conferring on them the freedom of the "guid toun." They were elected with all honours, "Burgesses, Freemen, and Guild Brothers of Campbelton, with power to them to bruick, and enjoy the privileges, liberties, and immunities belonging to Burgesses, Freemen, and Guild Brothers of the samen."

"My voyage," he writes to Neill, "was very agreeable. Mr Stevenson was most attentive, and enabled me to do a good deal. I regret much that we had no dredge on board. I was so fortunate as to find in Kirkwall Bay the *Asterias niger* of Muller, *new* to Britain, and in Loch Broom a *Terebratula* (recent) very different from the *T. cranium* from Zetland. It is more like a pecten, and bears a very close resemblance to some of the fossil species. I satisfied myself, beyond a doubt, that the reputed species of the genus *Pedicellaria* of Muller, considered parasitical on the Echinus, are, in fact, organs of that animal. In mineralogy my observations were too desultory and hurried to be satisfactory."

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* A paper in which hints were thrown out which have led to a correct estimate of the *Cilia* on such creatures.

"We are still somewhat at issue about the note on *Extensions*.* I do admit all your premises, but I deny your conclusions. Extensions do not die at (or near) a particular time, because the plant from which they were taken has reached the term of its natural death. There is no such law of vegetable life rendering the dissolution of both simultaneous, or nearly so, as the fact of the wall-flower demonstrates. But this is not the conclusion at which I aimed the blow. It was at the assertion of Smith, which you have in your paper (for which I return you many thanks) repeated, 'that *propagation by* SEEDS *is the only true reproduction of* PLANTS.' Now this is a barefaced assertion in opposition to innumerable facts, and it appears as a conclusion from premises which do not warrant such an inference. If I have still misunderstood Knight's views, it is because they are unintelligible, and many must be similarly mistaken, for the doctrines which I have attacked I have heard defended both in Scotland and Ireland, under the protection of Knight authority The note as now modified will, I trust, not appear so offensive as formerly. You attach too metaphysical a meaning to the terms *sympathy* and *identity*, and infer that I was speaking of the *stock* supporting grafts, when I had obviously in view the parent stock from which the grafts were taken. When I have more leisure, I may perhaps extend this note for the Horticultural Society. In some of its bearings the subject is curious, and might probably be rendered useful."

On his return, Dr Fleming had resumed his ministerial and scientific labours with renewed earnestness. He visited the households of his parish ; and to science, he communicated three interesting papers, entitled, "Gleanings of Natural History during a voyage in 1821," and published in the Edin. Phil. Journal. He also sent a notice of a Submarine Forest in the Firth of Tay, to the Royal Society. In this paper, he discusses several interesting questions, bearing upon submarine forests in general. Readers will notice, that even at that time (1822), he had come to question the hypotheses regarding shore-elevation and depression, which then generally prevailed, and which still influence several eminent geologists. Next year, he published his "*Philosophy of Zoology.*" This work contains the thoroughly matured thoughts of many years, on the important questions treated in it. An analysis of a work so well known by naturalists, is not needed here.* The following letter from Baron Cuvier will indicate the high estimate in which that profound naturalist held "The Philosophy of Zoology":—

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* By cuttings, and, as in the tulip, &c., by bulbs. See Phil. Zool., vol. i. p. 426.

"Monsieur,—Je connaissais déjà tout le mérite et tout l'intérêt de l'ouvrage que vous avez publié sur la Zoologie et que je m'étais empresse de me procurer; mais j'attache un nouveau prix à le tenir de votre main. Ce temoignage de votre estime m'est infiniment précieux et je vous en ai beaucoup de reconnaissance. J'aurais desire toutefois que vous éussiez un peu plus approfondi ma theorie des coexistences d'organisations et les applications nombreuses que j'en ai faites dans mon ouvrage sur les os fossiles, vous auriez probablement reconnu qu' elle s'éloigne moins que vous ne croyez de votre façon de penser, et surtout vous auriez evité de la présenter comme un appui du materialisme.

"Je ne vous en prie pas moins, Monsieur, de recevoir avec mes remercimens l'expression de mes sentimens les plus distingués.

"*Paris, Nov. 30th.* 1824. BN. CUVIER."

The work found its way into the hands of *M. Zendrini*, the accomplished Professor of Mineralogy and Zoology at Pavia, and was by him translated into Italian. It is still a favourite in Italy. "Dr Malcomson," says Hugh Miller, in a note to page 211 of "The Old Red Sandstone," "lately found an elegant Italian translation of *Fleming's Philosophy of Zoology*, high in repute among the elite of Rome."

Some time before giving this work to the public, Dr Fleming sent a copy of it to his friend Dr Barclay, than whom there was no better judge of the subjects treated of, and received the following communications:—

"*Edinburgh, Oct. 8th.* 1822.

"My Dear Sir,—I am now ready, after many interruptions, to communicate the opinion which I entertain of your first volume. The second I have not yet read, but have begun it, and shall peruse it with the same care and attention as I have the first. Upon the whole, your first is excellent, and will be of much advantage in conveying to naturalists, not only interesting, but very comprehensive views. If any things objectionable are to be found in it, I think they will be a few of your anatomical descriptions; not because they are incorrect, but because they are not sufficiently minute for anatomists, and more than too minute for general readers, to whom, without plates, a considerable portion of them must be unintelligible. Several of them, likewise, are descriptions of a species or genus into which many particulars are introduced which belong not to the order or class in general, and which ought not to enter into the idea which we are to form correctly of the whole. Your observations on the faculties of the mind are not only excellent in my opinion, but in some particulars even super-excellent, especially on instinct and reason, on liberty and necessity, and on the degrees of the intellectual powers possessed by the lower animals. Your observations on these subjects, I think, are new; and, as you state them, so obviously just, that it is a matter of surprise how they have not occurred to some hundreds of zoologists before your time. But philosophers, like others, have a partiality for far awa' fowls and fair feathers, and, like young fishers, are apt to cast their line on the opposite side of the river, though most of the fish which they labour to catch be on the side next to themselves. Men, in general, are too fond of dwelling on their superiority over the lower animals. They have neither wings to fly, nor fins to swim, nay, in comparing themselves with insects and quadrupeds they feel a pride in having only two feet to walk upon. And as for the reason of which they boast, it leads a few of them, it must be confessed, to a knowledge of God and to the cultivation of arts and sciences, but not a small number to poverty, sin, and wretchedness, to prison, exile, and the gibbet. Were you to start for a vacant chair in logic, moral philosophy, or metaphysics, and were I to recommend you, I should simply refer to your observations on the faculties of the mind, which are not founded on merely the speculations of the closet, but on accurate and comprehensive views of the animal kingdom at large. Excuse these few remarks, and believe me, my dear Sir, with much esteem, yours very truly, JOHN BARCLAY."

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* An analysis both of this work and of the "British Animals," was given by me in the *North British Review* for February 1858. The exposition of what is known as the "Dichotomous System of Classification," first proposed on the continent by *Lamark*, and in Britain by Dr Fleming, led to much controversy. The *Quinarians*, led on by M'Leay, were all in arms against it. Fleming dealt some heavy blows at the "Quinarians" in several journals, and especially in "The Quarterly," in an able article on "*Systems and Methods of Natural History*." If any reader wishes to see a full statement of this controversy, in which there are not a few topics interesting to the philosophic naturalist, I may refer him to Prof. Rennie's excellent edition of *Col. Montagu's Ornithological Dictionary*, a work which owes much of its usefulness to the previous improvements of Fleming.

"*Edinburgh*, *Oct.* 16. 1822.

"My Dear Sir,—I have now got as far in your second volume as page 437, and am much pleased with your excellent observations on the method of investigating the character of animals. There are many important remarks I see in your general descriptions, which are not to be found in the tableau elsewhere, as the Regne Animal of Cuvier. Blumenbach and Cuvier have certainly, in several respects, improved as well as altered the zoological arrangements of Linnæus, though I think that in general we oftener meet with alterations than improvements in such arrangements. I could wish that you, or one of such information as you, would publish a tabular view of the different zoological arrangements, and distinctly point out what are improvements, and what are mere alterations, proceeding from caprice, vanity, or a restless spirit for innovation. These alterations, changes, or improvements, or whatever they be, have done much to retard the progress and check the enthusiasm for natural history. I at one time thought that Cuvier, by his intimate and extensive knowledge of comparative anatomy, and by making it go hand in hand with the study of zoology, would have settled this restless anxiety for reform. But he seems to have placed too much confidence in structure, on the supposition that the structure regulated the intellectual powers, and what he calls the phenomena of organic life. That it does so to a certain extent, and, in many respects, is certainly true. Upon the supposition, however, of Aristotle, that the structure is formed to be subservient to the principle that animates it, and that the organs are accommodated to the powers or faculties of that principle, the characters of that principle, so far as they are indicated by dispositions, habits, and instincts, should not be overlooked; and especially as many animals of very different habits and instincts scarcely present any well-marked and obvious differences of structure, comparative anatomy falls here short of its object, and though it does much, we are apt to expect more from it than it performs. It can hardly predict from the structure and its organs the different instincts of the hare and the rabbit, or the different instincts of the common rook and the common crow. As you have admitted, and I think justly, both intellectual and active powers in animals, and both in some measure regulated through the medium of the animating principle, the different modes of its using the structure and the several organs over which it predominates, might form some important distinctions among the lower animals as well as man, where the difference of habit, genius, and manners, not the difference of structure and organs, chiefly occupy the attention of the novelist, divine, and civil historian. Mr Russel the surgeon, a great admirer of your works, was wondering lately how far the differences of character from disposition and habit might be added to the differences of character from structure and organs in zoological arrangements. He is not perhaps fully aware of the difficulties. In dead specimens, or in specimens from abroad, where the naturalist has never had an opportunity of observing them alive in their natural state, what can he do but confine his attention entirely to the structure, from which his knowledge of comparative anatomy will furnish him only with very general and vague ideas of the specific dispositions and habits. I am not such a master of zoological nomenclature as to form any judgment upon it, that would merit a moment of your attention. . . . .

"From the great pleasure and the quantity of information which I have derived from the perusal of a previous part of your valuable work, I proceed from page 437 to peruse the remainder, where I hope to glean some new ideas and instructions for myself, though, from my ignorance of the subjects that follow, I can hardly presume to trouble you any more with my remarks, which must appear insignificant to a well informed naturalist. The only additional remark which I have to make at present is this, that in page 409 you infer the existence of taste in mollusca from their selection of food. Now I believe that even in many of the warm-blooded animals, it is rather the sense of smell than of taste that directs them in the choice of food.—With much real esteem, and many thanks for the pleasure you have afforded, believe me, my dear Sir, yours most truly,

"JOHN BARCLAY."

When Dr Turton, the well-known conchologist, perused the Philosophy of Zoology, he wrote to Fleming :—

"Dear Sir,—Allow me to return you my warmest thanks for the entertainment and instruction I have received from your very interesting work on Zoology.

"Thirty years and more have I been an anxious inquirer into the progress of natural science, and can safely say that, except from the works of Linné, I have never been so fully gratified. It is just what this department of science wanted : a brief but sufficiently comprehensive display of this attractive department of human knowledge. Lamark is too diffuse ; Stewart is too confined. Your work ranks you not only among the scriptores feliciores, but among the fundatores.

"I entreat to be admitted among your correspondents, and shall rejoice in a communication and exchange of what can be mutually serviceable to each other's pursuits and wishes.

"My cabinet, although extremely rich in rare and valuable exemplars of the southern coasts, is yet deficient in the modern discoveries of the north. Your *Criopus anomalus* I once possessed a specimen of, but accident has deprived me of it. *Terebratula Cranium* and *Terebratula aurita*, are subjects that I much covet, but am afraid they are too precious to hope for the possession of; yet would I exchange for them specimens of new discoveries which can only come from my own collections.

"My new and splendid work on the British Bivalves it is probable you have not seen. In the fire which lately took place at Nixon's, the Copper-plate printer in London, my plates were destroyed ; and as few impressions had been taken off, the copies are become extremely rare. What, however, remain, will, I trust, fall into the hands of true conchologists ; and before they are all gone, I can offer a copy, for a copy of your own work, to send to my son in America—and some specimens of the *Criopus anomalus*, *Terebratula Cranium*, and *Tereb. aurita*. Any other of the northern varieties which you might think acceptable, I shall not only receive with pleasure, but endeavour to compensate for in exchange—if you will favour me with your list of desiderata. If you make a general collection of

British shells, I think I can furnish you with a dozen, or nearly so, of new and beautiful subjects, not yet edited, and of course inter rariores. Oblige me by an answer to this, as I am extremely anxious to establish a correspondence in Scotland, upon mutual principles of interest and science. I have the pleasure to be, my Dear Sir, yours truly and faithfully,

"Torquay, Devonshire, *July* 1. 1823." Wm. Turton.

The acquaintanceship thus begun, ripened into friendship between the learned, amiable, and enthusiastic, English conchologist and the pastor of Flisk.

Shortly after the publication of the Philosophy of Zoology, Dr Fleming transmitted a set of papers to Professor Jameson's Journal, which attracted very great attention at the time, and which are still to be regarded as valuable contributions to Natural Science, and one of them as claiming the attention of all who are taken up with the important physico-theological subject with which it deals. The papers forming this set are severally entitled, "*The Influence of Society in the Distribution of British Animals,*" "*Remarks on Modern Strata,*" and "*The Geological Deluge, as interpreted by Baron Cuvier and Professor Buckland, inconsistent with the Testimony of Moses and the Phenomena of Nature.*" These papers bear testimony to the closest habits of observation in the study of Natural History, to great discrimination, and to a rare capacity of induction. That on the Distribution of British Animals, called forth a reply from Dr Buckland in a letter to Professor Jameson, which was inserted in vol. xii. of the Phil. Journal. In the opening words Buckland says :—

> "Allow me, through the medium of your Journal, to express my obligations to Dr Fleming for the handsome manner in which he has spoken of my *Reliquiæ Diluvianæ* in your last number, and for the mild and gentlemanly tone he has maintained, while expressing his opinions on certain points whereon he differs from me. I perfectly coincide with that eminent naturalist as to the expediency and the necessity of illustrating the history of the Fossil world, by the analogies afforded by the structure and habits of living plants and animals, and by the operations of nature now passing before us."

Business called Dr Fleming to London, and on his way south, he spent some time in Cambridge, where, in the absence of his friend Prof. Sedgewick, Dr Henslow shewed him much kindness, took him to dinner in Jesus College, and led him to every thing of scientific interest in the university. When in London he wrote to Neill :—

"I have been at the Zoological Club, where I was introduced to all the leading men, and where I heard, for upwards of two hours, Mr Vigors preach on the affinities of birds. Of science there was little, but much that may be termed declamation. Nothing is the *go* here but quinary divisions, and groups returning into themselves. R. Brown promised to introduce me, but failed. I, however, have found in Mr Hope a most useful and intelligent friend. He speaks in the warmest manner of your kindness, and hopes to see you in town. The museum at the Indian House was open to me by Dr Horsfield, who seems an intelligent fellow. I was at the Royal Society, and heard an eloquent opinion of anatomical analysis by Dr Granville, on a mummy. He *demonstrated* the subject to have been a female, upwards of forty, to have borne several children, and to have died of diseased uterus and ovaria. Sir E. Home was in the chair. Last night I was at the Linnean, Sir J. E. Smith in the chair. Little was done of any moment, but I became acquainted with several new naturalists. Old Kirby pleases me much. On Friday, at the Geological, I met Buckland."

Dr Buckland's communication to Professor Jameson led not only to a reply by Dr Fleming, but to a full exposition of his views on the whole question of the Deluge, under the title quoted above. He experienced, however, some annoyance from Prof. Jameson's treatment of his MSS. To Neill he wrote in 1826 :—

"N.B.—I have sent you my Reply to Buckland. When I left you for London I was almost satisfied that no reply was necessary. In London I became convinced of the impropriety of *silence*. But instead of a reply, I have taken up the subject in a new form—taken the bull by ears, and carried the war into the enemy's country. The public will now judge who is in the right, and as I feel no dread of the hierarchy, I will maintain my position until vanquished by *truth*. The notes contain the reply, so that the general reader may read them or not as he pleases. I wish the paper to be read in the Wernerian Society as early as convenient, and to be printed in the first No. of the Phil. Jour. I will converse with Prof. Jameson when over on this subject. He led me into the scrape by asking me to write the paper on the Influence of Society. I hope he will form the ring and let me have fair play. To my own *prejudiced* mind my arguments appear incontrovertible. I long to hear your opinion."

Again, "My being curt, in some cases you point out, arose from my desire to shorten a long article. I think that even without the notes the Oxonian will have a hard morsel to chew—with them the thing would have been complete—but what can I do? The printer has a very poor opinion of my *prudence*, the editor has the prejudices of a professor in such full play, that he tries to screen a brother. Buckland may call me ignorant, announce my want of candour, and all this in him be proper, quite civil, gentlemanlike; but it seems, in the council of the editor and printer of E. P. J., that I ought not so much as to repeat by name these harsh accusations, much less make any reply, but quietly submit to insult, and ill usage, lest the pride of an Oxonian should be humbled."

Again, "So the journal goes on! And my 'paper in hands, minus two or three of the notes!' I confess I could wish *all of them in*, for I am not pleased with the manner in which the whole business has been gone about. My first paper was marred by the addition of two or three notes by the editor, injurious to its respectability. Buckland's reply appeared, but without notes. In fact, the editor stood by and saw me gored with rhinoceros' horns, and seemingly wishing my adversary success. Now when I offer to defend myself, a portion of my armour is withdrawn, and I am not permitted to fight in my own way. Nay, I am not allowed to be present at the conference, or consulted about the notes. Now, my good sir, tell the editor that I wish all the notes inserted, and that I will not be satisfied unless my wishes are complied with. I wish to act fairly to others, and as a Scotchman, *Nemo me*. In fact, it was in compliance with the wishes of the editor that I wrote the paper out of which the controversy has sprung, so that I consider him bound in honour to assist me, and not to lead the readers of the journal to suppose, as *some of them have* done, that his views are opposite to my own."

But that Jameson was not insensible to the merit of Fleming's papers, though chary of offending the Oxford savant, is evident from the following:—

"For Dr Neill. *University, Thursday.*

"My Dear Sir,—I will avail myself of your kindness to have a letter ready for L. Edmonstone. I have not heard of Fleming for an age. Buckland has been frightened out of his Deluge—by Fleming and others—but I am not disposed to give up the Mosaic Deluge—even geologically considered. Buckland's book is a failure, and therefore very open to censure. Yours ever faithfully, "R. JAMESON."

An extract from the summing up of the "*Modern Strata*" will shew how soon he had occupied the ground held in the *Lithology*:—

"In viewing these different groups of modern strata, it is surprising to observe the various causes which may have been concerned in their production, and the intermixtures of the individuals of the animal and vegetable kingdom, of fresh-water and terrestrial productions, with those of the ocean which have taken place. A most interesting question at the same time here presents itself, and one which involves some of the most important speculations in geology. Are we to consider the causes by which the different modern strata have been produced, as analogous to those which have contributed to the formation of the strata belonging to the more ancient epochs of the earth's history? If this question be answered in the affirmative, the occurrence of fresh and salt water deposits in the same hollow, and the remains of land and sea animals in the same bed, will cease to excite our surprise; and many of the irregularities, in thickness and extent, and arrangement, which the strata exhibit, will more easily be referred to their true cause. In such circumstances, the geologist will discover the importance of attending to the geognostical relations of the modern strata, and the laws which influence the physical and geographical distribution of the present races of organised beings; in order that, by proceeding from *the distinct to the obscure*, he may qualify himself for illustrating, with a greater chance of success, the various changes which the crust of this globe has undergone.

"In examining the peculiar characters of the causes which operate in the production of the modern strata, we discover, in their results, three groups possessing very different features.—In one we witness matter brought from an *unnatural state*, or from a high level above the sea, and deposited in a more natural condition, or nearer the level of the sea. Such are the depositions of detritus, lacustrine and marine silt, and lacustrine diluvium. In another, the causes in operation *prevent*, in some measure, the tendency of the wearing and lowering of the elevated parts of the earth, and the products are soil and inland sand-drifts.—In a third group, the matter deposited is brought from a natural condition, near the level of the sea, and elevated into an unnatural situation. Such are the products of shore sand-drifts,—of marine inundations, and of volcanic eruptions. How far these causes may have mutually counterbalanced one another, in the great scale, and during the different epochs of the earth, can scarcely be satisfactorily determined in the present state of geological science."

Shorter contributions to scientific journals shew how fully occupied he was at this period. To the Wernerian he sent a "*Description of a new species of Plumalaria, collected by the Arctic Expedition, under Capt. Parry,*" "*On a new British Species of Spatangus;*" to Dr Brewster's Journal, "*On the Neptunian Formation of Silicean Stalactites,*" "*On the Defoliation of Trees;*" and to Prof. Jameson's Journal, "*On British Testaceous Annelides.*" In the midst of these labours, he was not only working hard at his next great work, but was keeping up an elaborate epistolary correspondence with men of science. Indeed, many more than his admiring friend Neill were now willing to regard him as one of the first naturalists of the age. Among these was Sir William Hooker, who wrote to him in 1824 :—

"There are among Captain Parry's marine plants, collected in his late Arctic Expedition, a *Spongia*, one or two *Sertulariæ*, and a *Tubulariæ*, I believe. Being a stranger to this department of zoology, I should esteem it a great favour if you would name them for me, and write any remarks that might suggest themselves to you, to be inserted of course in your name in the appendix to the forthcoming narrative of the voyage." Again, "I must endeavour to offer you an inducement to come [to Glasgow], in assuring you that there is a very valuable collection of insects in the museum of our College, principally, as you are probably aware, named by Fabricius himself." And again, "I for my part have no faith in the metamorphosis of plants into animals, and *vice versa*. But I am quite alive to the difficulty of distinguishing the essential marks of the two kingdoms."

His eminence as a naturalist would appear to have had its drawbacks. He had been asked to write for Dr Brewster's *Journal*, and remembering the not very handsome treatment he had once and again received from the Professor, he was not unwilling to break with him altogether. Neill sought to heal the breach, and Fleming wrote to him not a little indignant * at the way in which he had been treated :—

"I have found Dr B.'s friendship uniform, and kind, and intimate—'the councils' † irregular, cold, and distant. As men of science there can be no competition. 'The council' is bolstered up by his professorial chair and the museum. Dr B. stands on a broad foundation of discovery and generalisation. Dr B. has mentioned my name on suitable occasions with respect; the Prof. has erased mine from his editions because it was coupled with *Thomson's* Annals of Phil. Geological relations which I have determined, in opposition to his avowed declarations 'that such things could not be,' have been subsequently silently presented to the world as his own. Nay, I have not a few proofs something approaching to ill usage. I know that he can compliment when he has an aristocratic motive—but I have found him acting as if I was not worth his while—others have suspected a little jealousy. Yet after all I am willing to keep on good terms with him.

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* "Anger is one of the sinews of the soul; he that wants it hath a maimed mind, and like Jacob, sinew-shrank in the hollow of his thigh, must needs halt. Nor is it good to converse with a man that cannot be angry."—*Fuller's Holy State.*

† *Jameson's.*

The publication of "The British Animals" (1828), added yet more to his fame as a naturalist. The subject had occupied his attention almost from boyhood. He had felt the want of such a handbook for students, and had resolved to supply it. To this task he had brought rare attainments in the knowledge of the literature of the sciences, and of the habits and habitats of the animals described, as well as of extinct species. It is not saying too much to aver, that few, if any, recent British Systematic Naturalists have not been obliged to it. This is evident from the references to it in almost every monograph in different departments of Zoology and Palæontology. The Palæontological part of the volume was a new feature in a work of this kind. It is indeed true, that in the progress of Natural Science, many additions have been made to the species there mentioned, and that such modifications have been made in systems of classification as to render it in a great measure of comparatively little value to a tyro in science. But to those who took from it their early lessons, and who have used it as a manual and book of reference, it is still invaluable. It is to be hoped that the time is not far distant, when a re-arrangement of its parts may be attempted, and such additions made to it as would bring it up to the present scientific point of view. The work received a cordial welcome from the most eminent naturalists of the time, and its claims on them still continue such, that he would be held little able for his task, who should attempt authorship in any department, into which Fleming entered, without a knowledge of his descriptions and discoveries. Among those who hastened to acknowledge the debt of gratitude which men of science owed to him, were his correspondent M. Zendrini of Pavia, and Sir William Hooker. The former wrote :—

"Je voudrais vous dire beaucoup de choses sur votre nouvelle ouvrage, *The British Animals*, mais je dois craindre de paraître flatteur sur tout a un auteur doué d'une à rare modestie. Sûrement c'est un modèle dans son genre, qui sera unité partout sù l'ordre rigoureux, la mésure convenable dans les choses, la sagacité des vues, et l'originalité seront appreuvés. Je ne me cesse pas de l'admirer, et je souhaite bien vivement de la voir appliqué a l'Italie."

Sir William Hooker wrote :—

"I beg to return you my best thanks for the present of your 'History of British Animals,' the appearance of which I had long looked for. I feel very glad it has fallen to your lot to publish this great desideratum, and I wish you might be induced to take in hand a similar work for an Universal Fauna. I presume you will do so as far as regards the Zoophyta, and if I can find among my Algæ any of this tribe which I may think will interest you, I will select them and send them to you. I think I had a few common ones (seeming to me at least) from the Cape of Good Hope, with some sea-weeds. I may probably be engaged here (Glasgow) all summer, as I have all Franklin's and Richardson's plants to describe, and very many from North America."

It is in every sense a *History* of British Animals; and the strong antiquarian tastes which characterised its author, enabled him to bring illustrations from many remote sources. Thus, under *Felis Catus* (p. 15), he remarks :—

"It is generally believed by naturalists that the wild cat is the parent stock of the *Felis Catus* (p. 15), var. *domesticus*, or common house-cat. Several circumstances seem to be at variance with this supposition. 1. The tail of the domestic cat tapers to a point, while in the wild cat it terminates abruptly. The head, too, is larger in proportion to the body. 2. The size is much smaller, a character at variance with the ordinary effects of domestication, though probably resulting in part from a poor animal or vegetable diet. 3. It would appear from the Leges Wallicæ, that, about the beginning of the tenth century, the domestic cat was highly prized; for, among the laws of Howeldda, relating to the prices of animals, the price of a kitten before it could see was fixed at a penny; till it caught a mouse, twopence; when it commenced mouser, fourpence. Had the cats alluded to been natives of these islands, it is not likely that so high a value would have been attached to them, especially if we take into consideration the ease with which they are reared, and the rapidity with which they multiply. The spotted variety, termed the cypress cat, is noticed by Merret, who says, (Pin. 169,) 'Enutritur in sedibus nobilium.' The domestic cat is probably derived from Asia, and may be regarded as one of the few of our useful naturalised quadrupeds. Its period of gestation is sixty-three days." So, under *Bos Taurus*,—"Several varieties, if not species, of oxen appear to have occupied the British Island, in a wild state, at no very remote period. Lesley ('De Origine, moribus et rebus gestis Scotorum,' Rome, 1678) mentions herds of '*Vaccæ non cicures*' (p. 10), which frequented the mountainous districts of Argyle and Ross. These probably were the parent stock of our domesticated varieties, which, with but little care, are reared in the remoter districts.

"The '*boves sylvestres*' of Lesley (p. 19), which were of a white colour, possessed, as he states, '*jubam densam, ac dimissam instar leonis;*' while Sir Robert Sibbald says, that, in his day, they did not differ in form from the common kind. The remains, however, of this white breed, with the muzzle and ears black, may be found mixed occasionally in our domestic kind. In a pure state, they are preserved in the parks of a few of the nobility. The remains of oxen, which occur in marl-pits in this country, seem all to belong to the species *taurus.* Many of the skulls, however, exhibit dimensions superior to those of the largest domesticated kinds. A skull in my possession measures 27½ inches in length, 9 inches between the horns, and 11½ inches across the orbits.

"The manes, which several authors state to have characterised the wild oxen of this country, and their remarkable ferocity, probably had a reference to the *Bos Urus*, a species once indigenous, as attested by the occurrence of its remains in the recent strata. A skull of this species, found by Mr Warburton, at Walton in Essex, forms a part of the collection of the Geological Society of London; and another skull found at Woolwich, exists in the Museum of the Royal College of Surgeons, London. This species differs remarkably from the *Bos Taurus*, in the front being swollen, broader than long, the horns taking their rise lower than the occipital ridge, and the ribs being fourteen in number instead of twelve. This species has now become scarce on the continent of Europe, and probably at no distant period will become extinct." Again, under *Cervus Dama*,—"The only notice of any animal of this kind ever having inhabited the British Islands, is contained in a paper giving 'An Account of the Peat-pit near Newbury, Berkshire,' by John Elliot, M.D. 'A great many horns, heads, and bones of several kinds of deer, the horns of the antelope, the heads and tusks of boars, the heads of beavers, &c., are also found in it; and I have been told that some human bones have been found; but I never saw any of these myself, though I have of all the others.' Phil. Trans., 1757, p. 112. The following passage of Torfæus (Hist. Orc. cap. 36), would lead to the belief that the *Reindeer* once dwelt in the mountains of Caithness, were it not extremely probable that red-deer were intended: 'Consueverant Comites in Catanesian, indeque ad montana ad venatum caprearum rangiferrum quotannis proficisci.' Several attempts have been made by the Duke of Athol and others to introduce the reindeer into the country, but these have hitherto failed."

While diligently working at *The History of British Animals*, he began a correspondence with the Rev. Wm. Kirby, a naturalist whom he much admired. In the end of 1826 *Savigny* had printed, and distributed among his friends and brother naturalists, his valuable monograph on the *Annelides*, and Dr Fleming was anxious to consult it. After several fruitless attempts to obtain a copy, he applied to the amiable and accomplished rector of Barnham for the loan of his, reference to which had been made in the "*Introduction to Entomology.*" In his letter to Kirby, he says,—"What would I not give to be within a day's ride of Barnham, and to have as an instructor the author of *Apum Angliæ.*" Mr Kirby readily forwarded Savigny's work, and, in a letter that accompanied it, he writes, "It is a great pleasure to me to be able to accommodate the author of *The Philosophy of Zoology*, and I shall expect with impatience the publication of *The Fauna of British Animals.* I am going to prepare a new edition of the whole of the *Introduction to Entomology*—if you will favour me with a list of such errors as may have struck you in the perusal of it, I shall be much obliged." This letter was not answered till after the publication of the British Animals.

"Since I had the pleasure," says Dr Fleming in answer, "of seeing you, I have been sadly interrupted in my labours by repeated attacks of inflammation in my eyes, a complaint from which I am now rapidly recovering. This circumstance has compelled me for the present attempting the publication of even a part of the 2d vol. The printing of the first is, however, I rejoice to say finished. It comprises the characters of the *Vertebrata, Mollusca*, and *Radiata.* I often wonder why so few attempts had been made to prepare British Faunas, but now when I reflect on the time occupied, the drudgery of synonime hunting, the obscurity of some descriptions, and the mis-statements in others, added to the carelessness or ignorance of compilers, I am inclined to think that many have begun the task and abandoned it in disgust, as I would have done, had the publishers not stood firm. Nor have I the slightest prospect of being repaid my expenses, to say nothing at all of the labour. I am in daily expectation of copies, and one will be forwarded for you, and may I ask you to note any errors or defects. Since I have been absent from the desk for several weeks, I find my eyes improving fast—though my hopes of recovery are but too frequently damped—'by the clouds returning after the rain.' I am enjoined to keep much in the open air for exercise, and trust that, in the course of the year, I shall add not a few insects to my small collection. But I feel sadly my want of help in species naming. Hope, indeed, in this respect has been my chief assistance, and he has acted most generously. If I could offer any thing in return, I would solicit from you a few 'bees,' of different genera, named by you as standards, but I fear I have nothing to offer worth your acceptance.

"In your letter, you ask me to send you a list of such errors as have struck me in perusing the 'Introduction to Entomology.' If my vanity was not kept in check by a consciousness of my entomological ignorance, I would have felt proud, indeed, of the compliment which you thus pay me. Lest you should consider me, however, as deficient either in gratitude or respect, I will add, reluctantly, some remarks which, from their insignificance, will probably satisfy you, that you have applied to a wrong quarter, and yet are they given with candour, as those which have actually occurred.

"1. Vol. i. p. 351. This story of moles buried by Necrophori, I believe to be without foundation. I have seen those beetles greedily devouring the maggots of the flesh-fly, and searching in the ground underneath for their pupæ. I have placed the pupæ in earth towards the bottom of a flower-pot, filled it with loose earth, laid a piece of bone or stone on the top, and then covering the whole with gauze, introduced some of these beetles. In a short time they had dug into the earth, and by their motion had, in part, buried the bone or other substance, by the earth being pushed up at its sides where there was least resistance. When I now looked for the pupæ they had disappeared, having been devoured by the silphæ. I have satisfied myself on this subject, and noticed the result in Phil. Zool. ii. 568.

2. *Ib.* 488. I believe Dr Barclay was not aware of the observations of John Hunter, Phil. Trans., 1792, which I have noticed in Phil. Zool. ii. 544.

3. *Ib.* 507. The wasps in this neighbourhood obtain their paper from the decayed surface of wooden posts, as I have frequently witnessed.

4. Vol. ii., 223. I am not persuaded that the final cause of the bee-like appearance of the volucillæ is to deceive bees. I had a dog who knew well the difference between a wasp or bee and volucellæ. The former he beat down with his paws from the window, the volucellæ he swallowed with eagerness. The bee which knows a stranger bee, might surely know a fly in disguise.

5. *Ib.* 362. The paragraph which begins at the bottom of the page I do not well understand. Caloric seems to excite muscular energy in insects just as it does in animals higher and lower in the scale.

"6. *Ib.* 447. The reference to Hunter at the bottom of the page should have been to Phil. Trans., 1792, p. 162.

"7. Vol. iii., 10. In stating the difference between the *Arachnida* and *Crustacea*, there appears some confusion in assigning a system of circulation, and gills to the former, produced apparently at the printing office.

"8. As you have signified your want of agreement with the Theory of Instinct given in the work, I, of course, am prohibited from making any remarks.

"9. *Quinary System.* I infer from the praises you bestow upon this system and its circular groups, that you have found it to hold true in the class

Insecta. I have sought in vain for proofs of its value among the *Vertebrata, Mollusca, Radiata,* and *Annelides.* I was glad to enjoy, in the spring of 1825, an opportunity of hearing Mr Vigors's demonstration of the doctrine in its application to birds. But so far from being satisfied, I still believe that by the same mode of procedure as followed by Macleay and Vigors, 500 circles could be made out as easily as five. I once thought of publishing my objections to this system, that some of its zealous votaries might be induced to try to obviate them, and that I might perceive in their strength or weakness where the truth lay. But I have withheld, as I dislike controversy. Yet it is painful to hear others rejoicing in the value of a discovery of new laws which they point out, and to feel such a degree of stupidity or ignorance as to be unable to perceive wherein the discovery consists. Such is my state, and I feel it the more as I am conscious I have, for the sake of acquiring some knowledge of the great laws of the animal kingdom, subjected myself to a good deal of reading, observation, and reflection, under circumstances ill calculated to encourage research.

Mr Kirby writes in reply,—

" *Barham, May* 16. 1828.

" My Dear Sir,—When I look at the date of your very kind letter, I feel quite ashamed that I have not sooner thanked you for it. I must plead, as some excuse, a more than usual portion of employment. I have undertaken to arrange and describe the insects collected in the late expedition of Capt. Franklin and Dr Richardson, which are numerous. I am likewise preparing a theological work for the press, add to which the correction of four or five sheets per week of the new edition of the Introd. to Ent., and my professional engagements, and you will allow that my time is valuably occupied. I must confess, however, that I am naturally given to procrastination, and will not say that I might not in all this have found time to thank you for your very acceptable communication.

" *London, May* 20.

" Thus far had I proceeded in my answer, when it occurred to me, that as I was going to town I might send this letter, together with a small box, containing a specimen of each genus of British bees, by a parcel from Longmans to their correspondent at Cupar-Fife. I called there yesterday, when they informed me they should have an opportunity of getting it conveyed on Friday. I therefore again take the pen to finish what was begun so long ago. I am glad Savigny proved so useful to you. It treats of a department of zoology to which I have never had an opportunity of paying attention, from my distance from the sea. I am sorry you have been suffering from too much use of the microscope as I conjecture. Eyes are useful organs that cannot easily be repaired, we must proceed fair and softly with them, and let them have their holidays. My own have suffered much from over use. Now I hope I am grown wiser, and if I find any tendency to inflammation, I throw aside the microscope for a time. I am greatly obliged by your kind intention to send me the first vol. of your British Animals, which I long much to see. Will you have the kindness to send it to Longmans, as I do not find it there. When the new edition is finished of the Introd. to Entomology, I shall desire my bookseller to send you a copy. You will find it more complete than the former. The two first vols. are finished, and we are half way through the third. I am much obliged by your corrections, but several of them were too late. If you consider what I have said in the letter on the Definition of the term Insect in the third vol., and in that on Systems of Entomology in the fourth, you will see that I have avoided expressing myself decidedly on the quinary or quaterno-quinary system. The coincidence of several naturalists, without consultation, forming such a system at nearly the same time, was the principal argument that induced me to regard it at all with an eye of favour, but I thought then, and am still more convinced of it, that it wants to be thoroughly sifted, and its weakest parts pointed out, before it ought to be received. I should like much to see the objections that have occurred to a naturalist so practised and acute as yourself in these departments which you have investigated. To confess the truth, I must confess that I have been rather disgusted by the attempt to face the system, and assume that it holds universally. I attempted to prove with regard to numerical systems that different numbers prevailed in different departments, as two, three, &c., as well as five or seven. What I most complain of, is, that the value of the groups is not sufficiently considered, and if the defender of any one of these systems can but find his *numbers*, he is not careful to *estimate* them properly, and ascertain whether they are primary, secondary, &c. No other difference should be in the value of each set of groups, than what may be produced in ascensu or descensu. As an instance in point, my friend Dr Horsfield, who is a man of great talent, and in general clear-sighted, but rather too deeply enamoured of the Quinary Arrangement, in his late number on the *Lepidoptera* of Java, instead of taking the obvious and natural division of them first given by Linné, and adopted by all modern writers on the subject, though under the name of *Diurna*, *Crepuscularia*, and *Nocturna*, has to make up the No. 5, split the *Nocturna* into three, *Bombysidæ*, *Noctuidæ*, and *Phalonidæ*, which are certainly of less value than the two others. In fact, the *Nocturna* are resolvable into mere equivalent sections, for the *Geometræ*, &c., and the *Tineæ*, should not form one group.

"But I don't know whether you will comprehend me, and therefore will not further pursue the subject. My only object is to shew, that I have not adopted this system *in toto*, but only think it may hold *partially*, but I should like to see a friendly controversy on the subject carried on by its friends and opponents. I am, my dear Sir, with great respect, yours very faithfully. "Wm. Kirby."

He had, like most other philosophic naturalists, an earnest love for the study of antiquities, and had made such good use of his talent, as to have attained to Archæological Generalizations so early as 1824, which are generally associated now with the works of Worsae,* and other Scandinavian antiquaries. His habitual caution, however, served him better than their love of generalization has done them. While acknowledging the great periods which they associate with, (1.) the use of stone weapons, (2.) weapons of bronze, and (3.) weapons of iron or steel, as indicating stages of civilization, he did not let the generalization so run away with him, as to hold that each period was well defined in itself, and separated by a broad line from the others. He held the contemporaneous use of all kinds, and associated his conclusions rather with the employment of instruments of a certain material for special purposes, and with the relation of the people to the raw material, than with their general condition. He would not have reasoned, when he found in the Bible "knives of flint" used in connection with circumcision, that the people, at that time, were so rude as not to know how to use iron and brass. So too with respect to modes of burial. One form of interment at a certain period does not warrant the conclusion, that no others prevailed. An opportunity had occurred of enlightening the district in which he laboured on some of these points, and he embraced it. An *urn* had been found in Tomb-den, Cults, and a letter had appeared in the Fife Herald craving information regarding it, and Dr Fleming wrote three letters on "Fife Antiquities" in answer to it. He says,—

> "So far as my observations extend, the *urns* which are found connected with *stone coffins* and *cairns*, throughout Scotland, are of two kinds, differing in size and the purposes to which they have been applied. The *small urns* are from three inches to upwards of a foot in diameter at the mouth, with a narrow base, and seldom exceeding fourteen inches in height. They usually consist of clay, tempered with sand derived from decomposed whinstone, such as may be seen at Scotstarvit, Drumnod, Luthrie, or the Black-cairn, near Newburgh. The texture, consequently, is coarse, though the

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* *Primeval Antiquities*, by J. J. A. Worsae. London, 1849. *The Danes in Scotland, England, and Ireland*, by J. J. A. Worsae. London, 1852.

surface in general is tolerably uniform. I have seen some, however, made with finer materials. The ornaments are various, on different urns, though found in the same cairn; but they are such as might have been produced by the thumb and nail, or a piece of wood. Bands of vertical zigzag lines predominate. These vessels appear to have been dried in the sun and then slightly baked in the fire, and are little inferior in value to the earthen vessels fabricated by some of the Highland clans at the present day. This kind of urn is usually found in cairns situate on small eminences, and in company with many others. Each urn is placed on its base *with its mouth uppermost*, and surrounded with flat stones set on edge and covered at top with a flag, thus forming a kind of coffin which seldom exceeds three feet in length or eighteen inches in breadth. In this kind of urn, I am inclined to believe, no bones are ever found.* The one from the Tomb-den, did not contain any, that were visible, and the blackness of the matter at its bottom and sides, which seems to have excited some doubts in the mind of your correspondent, may have been produced by several extraneous causes. In an urn, found in a stone coffin connected with a cairn, on the farm of Easter Flisk, a few years ago, no remains of bones were visible. It was brought to me before the earth which it enclosed had been disturbed, further than by the workman having thrust the end of a rib a short way into the surface. I proceeded to take out the earth with the greatest care, beginning to excavate round the sides so as to leave an entire pillar in the middle. But I did not perceive the vestige of a bone, or any thing different from common soil. Not, however, satisfied with this evidence of the absence of bones, or their ashes, I macerated a portion of the earth in muriatic acid, and added caustic ammonia, but no precipitate of phosphate of lime appeared, unequivocally indicating the absence of all traces of the earth of bones. I may add that the bones found in the cairn retained only their earthy portion, all the animal matter had disappeared.

"We cannot, however, regard all the cairns, which occur in Scotland, as having been erected over the dead, at a period antecedent to the Roman invasion. For many of these are known to have been raised at a comparatively recent date, as after the battle of Largs in the thirteenth century. But, in almost all cases, there are circumstances connected with the contents of the cairn, which serve to a certain extent for fixing the era of its formation. In the most ancient cairns, the rude urns are sometimes accompanied with stone instruments. Those which contain the remains of Roman arms, must have been erected at or subsequent to the period alluded to. Perhaps at nearly the same era may be dated those which contain bronze ornaments or amulets. But surely, at a much more recent period, must we fix the date of the erection of those, in which have been found iron spades, or stones with the sign of the cross. Besides these cairns and urns, which may belong to distant epochs in the history of the ancient inhabitants of this country; there are other sepulchral monuments, of a more recent date, which are interesting objects of inquiry to the Fife Antiquary. The first of these which may be noticed are STANDING STONES. Such monuments are usually regarded as of *Danish origin*, and intended to commemorate the fall of some piratical leader of that nation. This opinion is, to a certain extent, countenanced by the frequency of their occurrence in the northern parts of Scotland, even to Thule, which were the scenes of so many exploits performed by these Scandinavian adventurers, and to a very recent period so much under their influence. Perhaps an examination of the ground at the base of these stones, might furnish some evidence tending to fix the period of their erection. Indeed all these monuments, whether, as detached pillars, or disposed in circles, should be carefully examined. We see no reason to respect that morbid reverence for the monuments of savage tribes, which displays itself in protecting every cairn or circle, and planting the spot. While unexplored, they are as a sealed book, a dead letter. It is only by an examination of their contents that any light can be thrown upon the transactions to which they relate, or knowledge gained of the history of the people by whom they were reared. It is blind devotion then to cover them, and protect them by walls of tree roots—not more blind, nor more culpable than a reply which we once received while urging the propriety of opening an ordinary cairn: 'I am no fond about it, for they tell me that a man, east about, opened one of these old burial grounds, and a great many of his cattle died the next year.' Have any researches been made at the base of those standing stones which occur at Lundin, Pathhead, Balbirnie, or the one mentioned by Sibbald as situate at Doctoun, in the parish of Kinglassie? If so, what results were obtained?"

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* Not so: one in my possession contained charred pieces of bone when found near the Cromlech at Kipps, Torphichen.

His observations as a field geologist continued to increase in interest and importance. His attention had at a very early date, been turned to the Old Red Sandstone. He may, indeed, be regarded as the pioneer of British geologists in what has, mainly by the magnificent labours of Mr Hugh Miller, become one of the most interesting departments of geological discovery and research. In 1809, he described The Old Red of Shetland, as, in the nomenclature of Werner, Floetz Rocks; and for many years he seems, whenever his attention was turned to this series, to have looked at them as a man expecting hidden treasure. Nor was he disappointed. In a communication to *Cheek's Edinburgh Journal,* in 1827, he says:—

"In the summer of 1827, I obtained from Drumdryan Quarry, to the south of Cupar, situate in the higher strata of yellow sandstone, certain organisms, which I readily referred to the scales of vertebrated animals, probably those of a fish. The largest (see plate II., fig. 1, '*figure of a scale of the Holoptychius*,') was one inch and one-tenth in length, about one inch and two-tenths in breadth, and not exceeding the fiftieth of an inch in thickness. The part which, when in its natural position, had been imbedded in the cuticle, is comparatively smooth, exhibiting, however, in a very distinct manner, the semicircularly-parallel layers of growth, with obsolete diverging striæ, giving to the surface, when under a lens, a reticulated aspect. The part naturally exposed is marked with longitudinal, waved, rounded, anastomosing, ridges, which are smooth and glossy. The whole of the inside of the scale is smooth, though exhibiting with tolerable distinctness the layers of growth. The form and structure of the object indicated plainly enough that it had been a scale, a conclusion confirmed by the detection of the phosphate of lime in its composition. At this period I inserted a short notice of the occurrence of these scales in our provincial newspaper, the *Fife Herald*, for the purpose of attracting the attention of the workmen and others in the neighbourhood, in order to secure the preservation of any other specimens which might occur.

"Nearly a year after these scales had been discovered, not only in the upper, but even in some of the lower beds of the Yellow Sandstone, I was informed that *oyster shells* had been found in a quarry in the Old Red Sandstone at Clashbennie, near Errol, in Perthshire, and that specimens were in the possession of a gentleman in Perth. Interested in the intelligence, I lost no time in visiting Perth, and was gratified to find that the supposed oyster shells were in fact similar to those which I had ascertained to occur in a higher part of the series. The scales were, however, of a larger size, some of them exceeding three inches in length, and one-eighth of an inch in thickness. Upon my visit to the quarry, I found the scales, as in the Yellow Sandstone, most abundant in those parts of the rock which exhibited a brecciated aspect. Many patches, a foot in length, full of scales, have occurred; but as yet no entire impression of a fish has been obtained.

"Another scale, DIFFERING FROM THOSE ALREADY NOTICED (see plate II., fig. 3, '*figure of an oblong tubercled plate traversed diagonally by lines, which, bisecting one another a little above the centre, resembles a St Andrew's cross, and marked on the edges by faintly radiating lines*,') is about an inch and a quarter in length, and an inch in breadth. In external appearance it bears a very close resemblance to some of the scales on the common sturgeon, and may, with some probability, be referred to an extinct species of the genus *Accipenser*.")

A curious controversy arose afterwards out of the communications to *Cheek*. Fleming does not appear to have taken much notice of it, but Hugh Miller, with a noble generosity, not often, it must be confessed, exhibited among men of science, girded on his armour to do battle in vindication of Dr Fleming, whose early discoveries in *The Old Red* he was forward to acknowledge. In a note, already referred to in "The Old Red Sandstone," Mr Miller, with his unrivalled characteristic power of reply, thus puts the controversy :—

"May I crave the attention of the reader to a brief statement of fact? I have said, that Professor Fleming, when he minutely described the scales of the holoptychius, hazarded no conjecture regarding the generic character of the creature to which they had belonged; he merely introduced them to the notice of the public as the scales of some 'vertebrated animal, probably those of a fish.' I now state that he described the scales of a contemporary ichthyolite as bearing, in external appearance, a 'close resemblance to some of the scales of the common sturgeon.' It has been asserted, that it was the scales of the holoptychius which he thus described, 'referring them to an extinct species of the genus *Accipenser*;' and the assertion has been extensively credited, and by some of our highest geological authorities. Agassiz himself, evidently in the belief that the professor had fallen into a palpable error, deems it necessary to prove that the holoptychius could have borne 'no relation to the *Accipenser* or sturgeon.' Mr Murchison, in his *Silurian System*, refers also to the supposed mistake. The person with whom the misunderstanding seems to have originated, is the Rev. Dr Anderson of Newburgh. About a twelvemonth after the discovery of Professor Fleming in the sandstones of Drumdryan, a similar discovery was made in the sandstones of Clashbennie, by a geologist of Perth, who, on submitting his new found scales to Dr Anderson, concluded, with the Doctor, that they could not be other than *oyster* shells; though eventually, on becoming acquainted with the decision of Professor Fleming regarding them, both gentlemen were content to alter their opinion, and to regard them as scales. The Professor, in his paper on the Old Red Sandstone, in *Cheek's* Journal, referred incidentally to the *oyster shells* of Clashbennie—a somewhat delicate subject of allusion; and in Dr Anderson's paper on the same formation, which appeared about seven years after, in the *New Journal* of Professor Jameson, the geological world was told, for the first time, that Professor Fleming had described a scale of Clashbennie *similar to those of Drumdryan*, (*i. e.*, those of the *Holoptychius*), as bearing a 'close resemblance to some of the scales on the common sturgeon,' and as probably referable to some 'extinct species of the genus *Accipenser*.' Now, Professor Fleming, instead of stating that the scales were at all similar, had stated very pointedly that they were entirely different: and not only had he *described* them as different, but he had also *figured* them as different, and had placed the figures side by side, that the difference might be the better seen. To the paper of the Professor which contained this statement, and to which these figures were attached, Dr Anderson referred, as 'read before the Wernerian Society,'—he quoted from it in the Professor's words,—he drew some of the more important facts of his own paper from it, —in his late Essay on the Geology of Fife he has availed himself of it still more largely, though with no acknowledgment,—it has constituted, in short, by far the most valuable of all his discoveries in connection with the Old Red Sandstone, and apparently the most minutely examined; and yet so completely did he fail to detect Professor Fleming's carefully drawn distinction between the scales of the *Holoptychius* and those of its contemporary, that when *Agassiz*, misled apparently by the Doctor's own statement, had set himself to shew that the scaly giant of the formation could have been no sturgeon, the Doctor had the passage in which the naturalist established the fact transferred into a Fife newspaper, with, of course, the laudable intention of preventing the Fife public from falling into the *absurd mistake* of Professor Fleming. There seems to be something rather inexplicable in all this; but there can be little doubt Dr Anderson could satisfactorily explain the whole matter, without once referring to the *oyster shells* of Clashbennie. It is improbable that he could have wished or intended to injure the reputation of a gentleman to whose freely imparted instructions he is indebted for by much the greater portion of his geological skill, whose remarks, written and spoken, he has so extensively appropriated in his several papers and essays, and whose character is known far beyond the limits of his country, for untiring research, philosophic discrimination, and all the qualities which constitute a naturalist of the highest order."

In the spring of 1829, Dr Fleming wrote a paper for Professor Jameson* on "*The Insufficiency of the Evidence of the supposed change of Climate of the Arctic Regions.*" This gave rise to the "Pig's Foot Controversy" between him and Rev. W. Conybeare, the well-known author of the "Geology of England and Wales." The discussion deserves to be fully stated, because it is highly illustrative of several aspects of Dr Fleming's style and attainments.

It was very generally held, that the palæontological remains in northern latitudes warranted the conclusion that such regions once enjoyed a tropical climate; "At which time our rivers were swarming with alligators, our lakes with tortoises, and our seas with corals; when our caves were the haunts of bears and hyenas, and our forests the resort of the elephant and the tiger.

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* Edin. New Phil. Journal, vol. vi.

Nay, that in those northern regions, now suffering, during so great a part of the year, all the rigours of an iron winter, the climate was so mild as to permit the residence of the rhinoceros and the elephant." This had been questioned, mainly on the ground that the remains, though generally related to tropical species, are nevertheless those of kinds distinct. This led Fleming to question the soundness of the application of analogy in the determination of species, and in estimating climatal condition in old world ages. Cuvier, he said, though generally successful in its application in Comparative Anatomy, had been more than once led astray by it. In proof of this he quoted his remark,* that "any one who observes only the print of a cloven-foot, may conclude that the animal which left the impression ruminates; and this conclusion is quite as certain as any other in Physics or in Moral Science." "Observation, said Fleming, "had discovered many animals with cloven hoofs which ruminate; but in such circumstances would it be safe to infer that all cloven-hoofed animals ruminate? Conceive ourselves contemplating the footmarks of a sheep and sow. Under the guidance of Cuvier's declarations we would conclude that both ruminated,—an inference true in the one case and false in the other." Dealing still with analogy, he puts three questions,—1st, If two animals resemble each other in structure, will their habits be similar? The skeletons of the ermine, the polecat, and the otter, have a general resemblance, but how different their habits, &c. 2d, If two animals resemble each other in external appearance, will their habits be similar? The common shrew frequents grassy dry banks; while the water shrew dwells on the margins of ditches, and dives and swims with ease. How dissimilar the habits of the rook and of the jackdaw, of the heron and the bittern, &c. 3d, If two animals resemble each other in form and structure, will their physical and geographical distribution be similar? The zebra delights in tropical plains, while the horse can live in Iceland, &c.† But, have not the remains of the elephant and rhinoceros been found in Siberia? Yes, but are these individuals of a species identical with any of those existing at present in tropical climates? If it be denied, as it is, that they are similar, the general induction as to climate, is not to be depended on.

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* Recherches sur les Ossemens Fossiles, i. 51.

† I merely quote the illustrative cases, without giving an opinion on the merits. No doubt, however, Fleming had the best of the argument.

This paper created no small stir among the English leaders of natural science, and Mr Conybeare came forth to do battle with the Flisk naturalist. In the opening words of his reply, he makes a remark which was sure to awaken the indignation of his opponent. Dr Fleming is characterised as a "diligent and meritorious compiler in natural history"—a style of remark still common among not very well informed men, in reference to those who have outstripped them both in the field and in the library, under which they attempt to conceal that envy and jealousy of which generous natures are incapable. The strong points of Conybeare's answer were these,—1st, The fossil remains of zoophytes are those of the *Lamelliferous polyparia*. This family is found most fully developed in tropical seas. There are a few in the Mediterranean; beyond this latitude, according to Lamark's catalogue, there is only one. 2d, The only recent species of any size of *Crinoidea* is a native of the Indian seas. 3d, The existing species of the *Nautilidæ* are confined to warm latitudes. 4th, So with *Crocodilidæ*, and the *Chelonians*, with a few exceptions. 5th, So, too, with Mammalia—the elephant, rhinoceros, &c. The only conclusion, he says sarcastically, to which, under the guidance of his "Oxford Logic," he could come was, (1) that few, or almost none, of the above have their representatives in northern latitudes; and (2) that seeing we meet with the remains of such, either fossilised or with the texture of the skeleton unchanged, the climate under which they lived must have been similar to that in which their existing representatives now live—it must have been tropical.

The reference made by Fleming to the *sow* gave rise to an incident of a character somewhat ludicrous. In his reply Mr Conybeare alludes to it with great keenness.

"Living," he said, "in the country, I myself am in the habit of keeping some of these 'residuary legatees,' of all other animals, as a friend of mine calls them. Now, my pigs are not bisulcous, but wear four distinct toes on their feet, although the middle ones being most elongated and armed with large hoofs, certainly produce an external resemblance to cloven-footed animals, which has occasioned their being classed in the Levitical law, (which purports not to be a philosophical arrangement), as dividing the hoof though chewing not the cud. The impression of their feet in walking may, if carefully examined, (as Cuvier says,) be distinguished from the genuine bisulca."

Here then was a grave question, not for the minister of Flisk only, but for that band of Edinburgh naturalists, who had admitted his claims as a prince among them. Are Scotch pigs really bisulcous? The weightiness of the subject was at once seen! The wise Wernerians met, sat in judgment on the discussion, were perplexed, and had recourse to the way of use and wont in all societies, lay and clerical, of getting quit of their difficulties; they appointed a committee of their number—Messrs Robert Spittal, and Robert Stevenson, jun., to experiment, and report to next meeting. Their caution would have pleased Bacon himself. The Committee reported, *inter alia*,—"That with some difficulty they caused the pigs to walk across a board spread over with soft clay—that the impressions were in some places bisulcated—that in others, besides the bisulcous marks, there were those of two posterior toes—that owing to the unruly nature of the animals they could not make them walk along the board, when placed as an inclined plane, and that they had to place it horizontally," &c. The result, of course, was, after the usual committee fashion, to leave the question where they found it, having made a generous attempt to make out a case for both parties! Dr Fleming left the by-play as to the bisulcous hoof to the Wernerians, and turned to the strong points in Conybeare's reply in a fashion other than the committee.

"I will send," he writes to Neill, "in time for next No. of Jameson's Journal, my reply to Conybeare, which will make him stare. I see that Buckland's second volume is out, but I have not yet got an opportunity of reading it. Young Lyell is to be with me next week for a few days, when I shall enjoy some agreeable discussion. In looking over my paper which Conybeare has attacked, I cannot perceive a single sentence which could give offence to any one, still less is there anything to justify the insolence which he exhibited. He has misquoted me, and misstated facts to serve his purpose. How these things degrade science. Strange example of 'Oxford honour,' victory, not truth, being aimed at."

The paper duly appeared, and though there was much less keen feeling shewn in it than might have been looked for, as a reply it was crushing. A few detached sentences may indicate the mode of answer.

"In natural history I am styled a diligent and meritorious compiler; while in geology my information is evidently extremely limited. With the value or extent of my compilations from the works of naturalists, or from the book of nature, he is in ignorance, as the sequel will shew, and he is in the same state in regard to my geological knowledge." "He commences by displaying the extent of his knowledge regarding the distribution of the *Lamelliferous polyparia.*" "Personally unacquainted, apparently, with their physical distribution, he endeavoured to gain the requisite information by a process which indicated his incompetency for the task." "He consulted Lamark's Catalogue which its author does not offer as complete." "He must surely have heard of the *Systema Naturæ* of Linnæus, where the *Madrepora ramea* is recorded as a native of Norway." "If he could not have obtained a sight of the '*Systema,*' he might have consulted the '*Elenchus Zoophytorum*' of Pallas, and he would have found similar notices. But he should not have contented himself with even such compilations. *Lubuit enim integros adise fontes, atque haurisse.* In the '*Prodromus Zoologicæ Danicæ of Müller,*' he would have found notices of the following six northern species." "Had he imposed on himself the less irksome task of ascertaining the number of British species, and even opened my 'British Animals,' he would have found three species indicated as natives of our seas." "Mr C. says the few existing species of *Nautilidæ* are confined to warm latitudes. Where did he learn this dogma, uttered with so much complacency? In *Turton's Conchological Dictionary,* there are twenty-four species of this class enumerated, and in my 'British Animals,' thirty-nine as natives of our seas. *Turpe est in patria vivere et patriam nescire.*"

His remarks on Mr Conybeare's references to "*Crocodilidæ* and the *Chelonians,*" are even more trenchant and telling.

Dr Fleming had, for some time, reckoned among his valued friends Dr Gideon Mantell, famous for his discoveries in "*The Wealden,*" and the accomplished author of "Medals of Creation." The friendship led not only to the interchange of thought on geological subjects, which were rapidly attracting to them the highest minds of Britain, but to interchange of specimens likewise.

"*Castle Place, Lewes, Sept.* 21. 1829.

"My Dear Sir,—As there is no one whose correspondence I more highly value than yours I experienced the liveliest pleasure in your favour of 20th ult., and which I should have acknowledged immediately, but for the pressure of my professional engagements which left me not a moment of leisure. I certainly felt much disappointed in receiving no tidings of my volume for many months, but your explanation of the cause satisfactorily accounts for the delay. I have now only to regret my inability to render a correspondence with me at all interesting to you; my only hope is that you may be desirous of obtaining some of our fossils, and thus afford me a great pleasure in supplying you with any that you may desire for your cabinet. You know what my district contains; mention what would most interest you, and the best mode of sending them to you, and you will not find me negligent. Our mutual friend, Mr Charles Lyell, will perhaps afford us the most ready means of communication. On his return to London, I hope and expect he will visit me, and I shall thus learn how far he can facilitate the transmission of any packet to you. In the meanwhile, my dear Sir, do me the favour to write to me and tell me how I can be of service to you. Your kind offer I accept as frankly as it is made; the skull of the bear will interest me much, and indeed any other object of comparative anatomy. I am most anxious to obtain a good *cabinet* series of specimens of the primary and transition rocks; in short, from the coal downwards, anything will be acceptable. I am rich only in the beds above the coal-measures.

"I perfectly agree with you that the crag is a modern deposit, nor can I but think that future observations will rob many of our other deposits of a considerable portion of their antiquity. I am most desirous, and shall indeed consider it a great favour, if you will oblige me with remarks on my last volume, the Tilgate Fossils. I shall never publish another edition of either of my works, and they are both out of print, but I wish to form a popular volume on the geology of Sussex, in 8vo, with woodcuts, and give a general view of the stratification of this part of England.

"I have been very fortunate in my researches this summer, my grand prize is the tibia, fibula, and femur of an Iguanodon; these bones evidently belonged to the same limb, and are of a most appalling magnitude. I have also found the sternum and clavicle of the same monster. In the chalk I have also been very successful—two or three magnificent fishes have been found lately. A systematical catalogue of the fossils of Sussex is now printing by the Geological Society. for the next volume of our Transactions. I will do myself the pleasure of forwarding you a copy so soon as it is out.

—With great respect and esteem, and sincerest wishes for your health and happiness, I am, my dear Sir, yours most faithfully.

"GIDEON MANTELL."

"Should Mr Lyell be still in your neighbourhood, pray do me the favour to present my and Mrs M.'s best regards to him. He is no little favourite at Castle Place, I assure you."

Dr Fleming had forwarded to his friend nearly ninety specimens of rocks, and received the following acknowledgments :—

"*Castle Place, Lewes, March* 16. 1830.

"My Dear Sir,—I have deferred writing till now, that at the same time that I returned you my most grateful acknowledgments for your kind favour of the 18th January, and the interesting suite of specimens which shortly after reached me, I might announce the departure of a box of fossils for you; the latter was sent by waggon yesterday to our excellent friend Mr Lyell, who will duly forward it to you. And now, my dear sir, let me once for all assure you, that I feel most deeply indebted for your kind attention and most interesting present; you have given me the materials for a month's study when the spring comes in, and I unfeignedly declare that I value them even beyond their scientific value on the account of the donor. Your Philosophy of Zoology, which I read eight years ago, made me most anxious to become known to its author; and as there is no one whom I so much regard and esteem as Mr Lyell, the pleasure was the greater, that my wishes were realised through his kindness. You, my dear sir, will find, I fear, that you have encumbered yourself with a troublesome and useless correspondent. My object in the collection I have now sent you, was to give you a general idea of the contents of our chalk, principally the *Craie blanche*. Like yours my stock of duplicates is low, and I could not send so good a series as I wished; the greater part are uncleared, and require the chalk to be removed wholly or in part with a *sharp* knife or chisel (*first dipping* the specimen in water), and then washing them in water with a sponge or brush; the fishes and crustaceæ will not of course bear ablution. I sent the fossils in this state because they would be less likely to be injured in carriage. The polished specimens of aluminite (from the plastic clay near Newhaven) are very rare,—in other words, it is seldom the mineral is sufficiently compact to bear a polish. The firestone (*Craie chloritic*) is described at length in my 2d vol.; it is from Southbourn. The Sussex marble (containing *cypris paludinæ*, &c.) is, as you know, the uppermost beds of the Hastings formation; you have specimens polished—some with the parts of the shells in relief, and some of the shells broken out of the softer kinds of limestone. Again, à la Abernethy, I must refer you to my book. Unfortunately all our best fossils are large, very large. Our fish, *Ammonites*, *Nautili*, &c. are very heavy, and would not be worthy of carriage to Fifeshire. I have put in scarcely any specimen from the

Tilgate beds, reserving the productions of that formation for my next. The skull of Ursus arrived quite safe, and is quite a treasure. Your reply is very excellent; and I assure you the blows told well; you are a regular floorer; I will not put on the gloves with you; the *idola specus* was admirable! I perfectly agree with you that, "the effects of causes no longer in action' is absurd, except as applied to 'a particular district.' In that sense only do I wish the definition to be understood. I assure you I fully agree with Mr Lyell in the opinion, that the causes *now* in action are sufficient to produce (and have produced) all the phenomena of geology. The *Plesiosaurus* is recovered from his accident, you will have it in the next No. of Jameson; but really it is a pity your time and talents should be frittered away in controversy: truth will prevail. Lyell's new work (which is printed as far as p. 144) will do wonders; but the author will have a hornet's nest about his ears. He is a noble fellow, and will not mind it. Mr L. spent three days with me in the winter, and I was with him at the anniversary, 19th Feb. I wish I had taken a larger sheet of paper, I have so much to mention. I can now only repeat the assurance of my gratitude and respect and esteem. Yours, my dear Sir, most faithfully,

"G. Mantell."

"If you want any information respecting any of the specimens, please to ask while I remember them. A small paper on the Fossils of Sussex is at the bottom of the box."

His correspondent of 1807, Sir John Sinclair, was still labouring for his country's good, and had not forgotten him.

"I understand," wrote Sir John in September 1829, "that you have written a paper on 'The Wheat Fly,' but I have not been able to procure a copy of it. As I am now engaged, however, in the same inquiry, I should be glad to see your thoughts upon it. In the interim, I have the pleasure of sending you the sketch of a paper which I have written upon that subject, on which I should be glad to be favoured with your remarks. It is a matter of such immense consequence to the general interest of the country to prevent the depredations of such destructive vermin, that we must combine to probe the subject to the bottom."

CHAPTER IV. 1829 to 1834.

Dr Harlan of Philadelphia—Entomology—Rev. F. W. Hope—Chair of Agriculture—Household Afflictions—Friendships—Buckland—Lyell—Mantell—Presentation to Clackmannan—Lord Dundas—Letters to Neill—Retrospect—Professorship of Nat. Phil. King's College, Aberdeen—Memorial of his Parishioners—Testimonies to Ministerial Fidelity.

Dr Fleming's name was now well known, not only in Britain and on the Continent, but in America likewise. Dr Harlan, a distinguished physician and zoologist of Philadelphia, kept him acquainted with the progress of his favourite pursuits in the United States.

"I acknowledge," he says, "with pleasure the receipt of your *Fauna Britannica*, precisely such a work as was needed in British Zoology. As far as I have read in it the last two days, it answers my highest expectations. In the Jour. of the Acad. Nat. Sc. of Philad., Mr Say has adopted your classification of the tortoises, forgetting to mention your name. The Bulletin des Sc. Nat. of Ferrusac, as well as Bell, a writer in the Zoolog. Jour. of London, have adopted the genus *Cistuda*, and refer the name to Mr Say—though his paper occurred two years after your Phil. of Zool.—a work which I lent him for perusal, and he expressed himself highly pleased, both with the style and matter. Some of the London Zoologists appear to me very superficially read in their own department, and in your case, have shewn themselves ignorant of the author's works, whose improvements they have unknowingly adopted." "I wish to send you a copy of my *Fauna Americana*,* and some other lighter publications of my own, extracted from various journals. I correspond in Paris with Baron Cuvier and Desmarest, and am personally acquainted with the American Minister, Mr Brown; in England, with M. Lawrance, Surgeon, Dr Horsefield, of Java renown, and Mr Griffith, one of the authors of 'The Animal Kingdom.' Any of these gentlemen would forward a packet to me, should you have occasion."

The correspondence with Kirby referred to above, shews that Dr Fleming had early given some attention to *Entomology*, a branch of natural science in which, notwithstanding the low estimate he had of his own attainments, he had made much progress. During the last thirty years great advancement has been made in this delightful field of observation. This could not fail to be the case when the energies of such men as Kirby, Spence, F. W. Hope, J. O. Westwood, S. Stevens, &c. were enthusiastically devoted to it. Dr Fleming was elected a member of the Entomological Society of London. Few of his correspondents enjoyed so much of his esteem and love as Rev. F. W. Hope, whose letters to him must often have cheered him at times when his mind turned to the tardy recognition of his pre-eminent abilities as a naturalist, by those who could have easily done him substantial good. A most successful field entomologist, Mr Hope seemed to return from his rambles, in the neighbourhood of Netley or in the New Forest, not only laden with lots of rarities, but with the sunshine of his out-door studies around him, to report progress to his friend in Scotland:—

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* Limited to the Mammiferous Animals of N. America.

"Dear Fleming,—I have just returned from a marine or coast entomological trip, which a too close application made absolutely necessary. My success far exceeded my expectation. . . . . . I shall, of course, reserve species for your collection. At Sheppey, Crustaceous fossils attracted my attention, and among them, Desmerest's species, viz., *Xantho Leachii* and *Inachus Lamarkii* in abundance. It was my intention to have shipped them all off to Cupar along with the fossils, but Sowerby has disappointed me. . . . . . Of course, you are busy collecting. Mind I expect numbers of fine things, and among them *Elator riparius*."

In another letter—"Your letter pleased me greatly, as you give a good account of yourself, which is better than all the collections of Scarabæi, &c. You are now public property, and must, therefore, take care of yourself. I agree with you, it is a bad year for Lepidoptera. I have never captured so few—really the flowers have not had their usual sweetness. Sowerby promises to have all the fossils ready by my return to town, when I shall send you and Wilson a pretty considerable parcel. You shall have the whole of the Crusta-ceans to examine. Presume not too much on your health, *i.e.*, be not always in doors." Again—"Would no inducement lead you to the focus of Science? I may be selfish in desiring a more intimate connection with you, but not entirely so, as I am thoroughly convinced, there are many choice spirits, who would hail your arrival amongst us." "I always look forward with pleasure to the arrival of a Fife letter, although a tinge of melancholy sometimes pervades them." "This year (1831) I have visited the New Forest twice, and have captured more novelties and varieties than ever. Pray send me a list of your *named* species. I have now many hundred duplicates, and it will be your own fault if you do not take advantage of them. You will be glad to hear I have purchased all the Crustacea of Sowerby's collection, and there are none of them which may not be unacceptable to you."

The "tinge of melancholy" which Mr Hope had observed in some of his friend Fleming's letters, like a shadow thrown into the midst of sunshine, was the result of a feeling which was year by year growing more intense, even that the position he occupied was not one in which he could ever find scope for his talents, while translation to a suitable one seemed to imply an attitude to patrons or to political parties, to which he was little willing to stoop. Neill knew all his private thoughts on these things; but, in order to help him, his zeal sometimes outran his discretion. In 1831 a professor was required for the Agricultural Chair in the Edinburgh University, and remembering the insight which Fleming had enjoyed into practical agriculture on the farms of his father and brother,—remembering, too, the relationship into which he had been brought to the Board of Agriculture by Sir John Sinclair, and having high views of the great benefit which would be conferred on his native country, if one should be elected to the chair who would link up lectures on the Theory of Agriculture with Geology and Chemistry,—Neill wished him to become a candidate. But Fleming refused, and in turn suggested the chair to Neill himself.

"I wish the University may get a professor capable of teaching agriculture as a science, and not as a trade, and if I might give a hint on the subject, I would wish to see the chair filled by one who has studied the sister science of Horticulture in an intellectual manner, and who might turn the Experimental Garden to good account as a useful establishment. I would even urge you on this subject to make an effort. You would require no certificates, but if you did, it would amuse and delight me to write one.

"I regret to observe that you have acted, subsequently, in a way, really I must out with it, not like yourself. Has Dr Macknight talked to Dr Gardiner? Mr Blackwood, Convener Chambers, Convener Marshall, &c., are sounded, so that by this time it is pretty generally understood that I am, or wish to be, a candidate. Now this is not as it ought to have been, because it is not the way to introduce an individual to the favourable notice of those in power, by exhibiting him as wishing to occupy a place to which he ought not to aspire, and I am satisfied, that upon reflection, you will arrive at the same conclusion."

He had now been more than twenty years in Flisk, and, though he was firmly persuaded that a change would be of advantage to himself, to his parish, and to his family, he says in the same letter that he ought to be contented, because "he had been detained there by the decision of a good and wise Providence." The desire, however, at this time for another position had become so strong, that he once entertained the thought of emigrating. But, while these desires were filling his mind, he was made far more clearly aware than he had ever been, how truly his times were in the hand of a covenant God, and his lot ordered by Him. The providence which he acknowledged in his continuance at Flisk, came to stand out in his convictions, not so much as the expression of a controlling sovereign Will, as a scheme of paternal discipline. One of those strokes fell on the quiet, cheerful, joyous circle in the Flisk manse, which ever direct the children of God from their loss up to Him. Never seems the unseen world so near and real—the blood of Christ so precious—and the hope of eternal life, and of the resurrection from the dead so full of strength to the spiritual nature of man, as when death enters the Christian household, and quenches some light of the dwelling. So it was proved now. And as to his desire for a change of residence, he was made to feel how ways could be opened up to him. The following letter to Neill will illustrate and explain these remarks :—

"Again and again have I wished to write to you, since our awful bereavement, but I have not had courage. I desired Robert Christie to call and give you the particulars of an event, which will leave its record on our minds while we live. The boy was our pride and pleasure, and we have since been convinced, that he was esteemed by others as well as his parents. In our secluded spot and small family circle, he occupied a prominent place. Healthy and active, he seemed to have fair prospects of life. Unreservedly we loved the gift, considering this nothing more than thankfulness for its value. He was our friend and companion. Conceive our anguish, when an awfully desolate blank occupies the place which he possessed—within or without his memory is linked with every object. Yet the very worth which makes him remembered, soothes us a little. During his distress, he displayed so much that was amiable, as to lead his mother and I to say that if he got better, we would love him more than ever. We saw that our exertions to improve him had been blessed. We believe him with the Redeemer. This conviction enables us to temper the feelings of the parent with the faith of the Christian, to a certain extent. But, alas, the wound is in flesh and blood, and when it may heal, I know not. During his illness, I was in some measure stupified, now I feel a changed state, and when disposed to read the lesson, I smart under the discipline.

"We feel for your state with cholera at your door—yet is it worse than typhus? In our quarter, no appearance of the disease has broken out.

"I have read Chalmers's blow up of the Commission. It is a masterly production, done equally in the style of business and good taste. But it places the College of St Andrews in a very awkward predicament. I trust our friend Prof. Jameson will come forward and vindicate himself from the aspersions which have been cast upon him by these Royal visitants. I really felt indignant, when I read the account of all that could be said against the museum, without a redeeming statement.

"You may probably have heard, that immediately after the death of the minister of Auchtermuchty, the parishioners obtained from the patron, Bruce of Falkland, a promise that he would meet the people 'half way' in the choice of a minister. I was looked to, and after a deputation came privately to hear me preach in my own pulpit, and heard me in Auchtermuchty in my Presbyterial course, a petition was got up in two days, embracing magistrates, resident heritors, feuars, tenants, weavers, &c., male adults above twenty years of age, hearers or members of the church, to the amount of nearly 400 (every one but the town-clerk who had a candidate of his own), *being a unanimous call from the parish.* The most complete, even a worshipper of popularity could desire. I feel that a very handsome compliment has been paid to me, a public testimony to my character, on my part unsolicited and unexpected, on theirs perfectly spontaneous. It can do me no harm."

The irritation which Dr Fleming's papers on the Deluge had caused in the minds of several of his English fellow-labourers in the field of natural science, had passed away. Men had begun to look beyond the sarcastic remark, biting allusion, and somewhat contemptuous manner with which their *theories* had been met; and had discovered a warm, generous heart beneath all. They saw, too, that no man was more ready than he to accept with gratitude every addition to man's knowledge of nature. "Even Buckland and I," he writes to Neill, "are now sworn friends." "I am much pleased with Lyell's Geology—though, strange to say, he makes no mention of Moses and of Jameson. The former he omits through prudence. I fear that the Edinburgh school has sunk to rise no more. Wernerianism is being universally admitted to be a humbug, and harmony and co-operation in Auld Reekie unknown." "I have just received another letter from Mr Murray of London, beseeching more contributions for the *Quarterly,* and a series of vols. for the *Family Library.* I intend to send soon another antiquinarian broadside." His intimacy with his friend Mantell was becoming closer. In August 1832, Dr Mantell wrote:—

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same year (1832) he was presented by Lord Dundas to the parish of Clackmannan. Lord Dundas's father, the first Earl of Zetland, had kept Dr Fleming in mind from the time he was appointed to Bressay. When he had been several years in Flisk, his Lordship wrote, informing him that he had applied to Lord Lauderdale (1818) to present him to the living of Colinton, near Edinburgh. "I am extremely sorry," he said, "to think that there is a chance of losing you from Flisk, and I must tell you in confidence that I had in view the appointing you to Clackmannan in the event of a vacancy there." On the death of Dr Moodie, Lord Dundas before hearing from Dr Fleming, took immediate steps to have him settled in Clackmannan. To his friend Neill he hastened to intimate the appointment:—

"How painful is change! For twenty-one years have I been minister at Flisk. At first, I was anxious to get away, because I courted a more active life. More lately, my anxiety for removal was influenced in a great measure by paternal feelings. Now the change has come, but he is asleep for whose sake it was chiefly waited for; and for the last five months have I witnessed the *turf* and thought of *the change*. As far as matters have gone, the circumstances connected with Clackmannan are agreeable. I have found the parish in a perfectly comfortable state and willing to receive me. I have much of this to refer to our good friend Mr Bald, who has acted a kind part, just as I expected of him. The Presbytery of Cupar has acted equally friendly, and I leave Fife with good grounds for being gratified for a public testimony in my favour. Before me is a field of labour which, ten years ago, I would have been better able to cultivate. However, the events of providence do not obey our direction; and I enter, in the course of the month, on the scene with an honest desire to do my duty. I have enjoyed some proof of popularity in Fife! This has not been gained by courting the prejudices of the day, but by a straightforward mode of acting—consistent I hope. The same course I intend to follow at C.; and although I cannot hope for so long a lease there, according to my will, as I have had at Flisk against my will, yet I trust to live long enough to do some good." Again,—"My good friend, your scold was gratifying to me, because I know your perfect sincerity, and also, that it was of a prospective nature. I may, however, state, that we are at one in reference to the clerical duties of Clackmannan. A parish of less than 300 souls requires attention from a minister very different in quantity, and perhaps in kind, than a parish with more than 3000 souls. In the one case, there may be much spare time, in the other there must be continued labour. This increase of duty and anxiety comes upon me, it is true, at a time when much of the force and zeal of youth have fled, and when care and comfort would have been more suitable. But I have no choice. I have been cast by providence in a secluded situation, with a stinted income, and exposed to the malevolence of those who fancied that I might interfere with their interests. In this way the best of my life has been lost to the public, but the accompanying discipline has not, I hope, been lost upon myself. If you mean to say that I am *thought* heterodox, I can only reply that it is not intentional if I be so; and I have reason to believe, aye, *good reason*, that I am not thought so by those who have the best opportunities of judging. But if orthodoxy consists in talking much about religion and doing little, in the exhibition of practice opposing profession, in slandering an individual with a view to prevent him gaining what he would wish to secure; if these be the tests of orthodoxy, let your friend Mr M. enjoy the honour of saintship. No, no, Mr Neill, all is not gold that glitters, as you well know, and as I have experienced. But I am independent. Lord Dundas is a man of honour, and *will present* me—in fact, all is arranged. Then will I try to do my duty, quietly and unostentatiously, hoping for my reward, not from a few political jobbers or managing women, but from the Judge of all." . . . . "You are not surely serious in supposing that I put on your remarks about not preaching in Edinburgh, and Mr Smith's opinion on the same subject, any other interpretation than that you were playing off a little irony, as I believe the idea of my getting an Edinburgh church never entered the head of either. I am well aware how I stand in the Church. To be successful one *must be of a party*, and then the threads of his interest can easily be extended into a powerful cord. I have hitherto enjoyed my independence, and do not belong to a party. . . . This time last year I heard the Professor of Natural History in Edinburgh in his Introductory Lecture, state that Smith and Hooker and Greville had done much for British Botany, but that the field of British Zoology remained *untouched*—not a reference to British Animals!! L——, who was with me, declared that nothing but personal evidence could have induced him to suppose or believe that the Professor 'had such a head and such a heart.'

He was not, however, permitted to continue long in his new sphere of labour, where he had entered on the work of the ministry with great zeal, and where his work, both in the pulpit and from house to house, was much valued by an affectionate congregation. In 1834, a vacancy having occurred in the Natural Philosophy Chair, King's College, Aberdeen, the Senatus, who are the patrons, cordially offered it to Dr Fleming. His correspondence with eminent men bears testimony that his literary and scientific triumphs, whilst minister of the rural Fife parish, had directed, once and again, his mind to the *toga honoraria* of a University professorship. His eminent friends also had frequently suggested this to him ; and, now that it was within his reach, it is not to be wondered that he accepted the chair. But it was with much reluctance. He felt the strength of his present position—had no reason to doubt but that his work was being owned of God—and had, month after month, increasing proofs of his acceptance among a people now much beloved. Before indicating the tasks to which he gave himself as a professor, it may not be uninteresting to take a retrospect here of his work as a minister of Christ.

During the very brief period of his ministry in Bressay, he had so won the regards of his parishioners as to lead them to consult him, even in regard to their domestic affairs. There is proof among his papers that he wrote letters for them to friends at a distance, and it has been to me full of interest, to read the affectionate references to " Mr John Fleming" in the answers to these letters, chiefly from sons of the fishermen, who had been "pressed" into the naval service of their country. Such facts shew that the accomplished young naturalist must have given most of his time to the simple people among whom his lot had been cast. If he was zealous as a naturalist, and this has already appeared, he was more so as a pastor, and as the Christian friend and counsellor of his flock. His remarkably busy years at Flisk, in literature and science, had not left him without time for what he ever regarded the business of his life as a minister. Many illustrations of this might be quoted, but it is enough to refer to the movement at Auchtermuchty in his favour. The people there were intimately acquainted with all his pursuits ; and all who know the extreme jealousy which exists among Scottish people of the very appearance of a divided attention on the part of a minister, will at once see the value of this testimony to Fleming as a preacher, and as a pastor set to watch for souls. The character of his labours as a faithful minister, is even more apparent in connection with his last charge. When the people learned that he had been offered the Chair at Aberdeen, the following " call" was addressed to him to remain among them :—

"*Clackmannan*, 17*th May* 1834.

"Reverend Sir,—We the undersigned Heritors, Elders, Heads of Families, Communicants of the Church, resident in the Parish of Clackmannan, learning that the honour of an appointment to a Professor's Chair in the University of Aberdeen, has been bestowed on you, it is with the deepest regret we look forward to the connection of pastor and people being broken. Should this be the case, we can only express our anxious hope that health and happiness may long enable you to discharge your duty in your new sphere of usefulness; but as we learn that the appointment has been made without any solicitation on your part, we beg to assure you of the high gratification we should all experience if you resolve on remaining among us, and continuing that relative connection with this parish, which we so much regret should cease at a time when the benefits of your ministerial labours have been so extremely useful, and are so highly valued. We also beg to assure you, that, viewing the great extent of the parish, should it please Divine Providence to spare you to officiate in your ministerial capacity here, and in the course of time should your health require aid and assistance from the parish, you may rely on our ready concurrence. We thus, Reverend Sir, place this call in your hands, and should you be pleased to remain at Clackmannan, the most unfeigned joy and sincere pleasure will be given to us all."

This document is signed by 418 male communicants. The first signature on the list being that of Robert Bruce, Esq. of Kennet, a gentleman well known for his Christian zeal and philanthrophy. Mr Bruce wrote to him after his mind was made up: "I fear we shall have deep cause of regret for your removal, and for myself, my regret is of a selfish nature, feeling sorry to lose as a pastor one whose friendship I much esteem and desire to cultivate. You will leave behind you many who will not forget you, and I hope remember your instruction given while you laboured in the parish." His old and valued friend, Mr Robert Bald, Engineer, and a "Wernerian," was immediately informed by Dr Fleming of the appointment, and wrote to him: "May the Almighty, who directs all events for the good of all those who put their trust in him, direct your views and determination in this very important matter, both as regards time and eternity." From Cheltenham, James Stewart Menteith, Esq., wrote: "No one regrets both yours and Mrs Fleming's leaving C. more than my sister, Lady Mar, who can never forget the many kind, friendly acts on your part, and on that of your good lady's, to her on more than one occasion."

CHAPTER V. 1834 to 1843.

First Session at Aberdeen — A Degree for Neill — Phrenology — Diluvian Hypothesis—Justice to Scotland—Scales in the Old Red—Superposition of Strata — Dichotomy—Deal Fish — Ichthyolithus Clackmannanensis—Visit of Agassiz and Buckland—Old Red —Ecclesiastical Controversies—Non-intrusion—Letters to Neill on Church Principles—Aberdeen Phil. Soc. and Contributions—A New Skate—Yarrel—Selby—Dr Johnstone of Berwick.

Dr Fleming entered on his Aberdeen Professorship with much zeal. The subjects to be discussed during the first session, though of a kind with which he had long been well acquainted, yet demanded much preparation, in order to their accurate handling in the class. To the labour implied in this, he gave himself most cheerfully, but his health began to give way. Symptoms of that bodily debility, to the attacks of which he became increasingly liable till the time of his death, began to appear. Having, however, the summer months for recruiting his strength, each returning session found him ready to enter vigorously on its labours. During his first winter at King's College, he had the satisfaction of reporting to Neill, that on his recommendation, the Senatus had conferred upon him the degree of LL.D. "I proposed the degree," he says, "because I was anxious when in my power, to offer a tribute of friendship to one who, independent of friendship altogether, more than merited the honour. In the latter view of the matter, I was borne out by the testimony of all my colleagues, and I am equally confident that all who knew you, will approve of the deed." To the same he writes:—

"*King's College, 28th October* 1835.

"My Dear Sir,—You know that I hold phrenology in scorn, i.e., as at present taught as established. I will even go farther and say, that if Combe believes in the soundness of his logic, I believe that he does not know what correct reasoning is. His facts are generally assumptions, simple probabilities, and not very strong, and are made use of as certainties, and he is continually *reasoning in a circle*. This is plain speaking to you who admire the science so greatly. I am at one with you as to studying the phenomena of mind *more physiologically* than Reid or Stewart ever did, or were capable of doing. I admire every observation on the influence of disease on the functions of the brain. I hail every fact of this kind as a positive addition to mental philosophy. I have even no fault to find with individuals attempting to connect with external form or relative size, certain manifestations of character; but then, I take the liberty of judging for myself respecting the value of the conclusions at which they have arrived, and I do this the more readily because I can observe the same phenomena. Here we differ, let us part with bumps in peace.

"Many thanks for the first number of 'The Naturalist,' in which 'British Animals' is complimented and bantered at the same time. My opposition to the *Diluvian hypothesis* occasioned not a little ill will towards me among the *tail* at Oxford and Cambridge, and in the Geological Society. My refusal to embrace the *Quinarian* nonsense of Macleay made me the object of the virulent persecution of the cockneys. These things joined with the anti-Edinburgh spirit of London, and the coldness in Edinburgh of those who might have furnished some protection, have placed me rather as an *outlaw* than as one who has made great sacrifices for science. It was bold indeed in the fellow, whoever he is, to have ventured on a defence however guarded. *Nil desperandum*. I have seen quinarianism almost asleep, and the Diluvian hypothesis expire with Buckland's Bridgewater Treatise.

"Except the chemistry of the manufacturers, there is little of science in progress here. I have been disappointed in several things, the Dolomite of Aberdeen is Tremolite, the Pinite is Schorl,* and even the new species instituted by Thomson 'Davidsonite,' will prove Emerald and Donium glucina.

"How strange that Scotland should have been insulted in her Universities. Cambridge, Oxford, and Dublin—rich bodies—and who enforce the delivery of the books, and therefore oppress the trade to the greatest extent, they have been protected. The Advocates' Library, in similar circumstances, has been protected; but the Universities which did least injury to the trade, stood most in need of the boon, have been singled out. Oh for a *Scotch O'Connel* to cry out '*Justice to Scotland.*' Willingly would I contribute a *Rint* when I see the way we are always treated."

Shortly after this, Professor Jameson, ever anxious to avail himself of Fleming's papers for his Journal, if not ready to give prominence to his works in the presence of his class, wrote to him with a cordiality which does not frequently appear in his communications. "I shall have pleasure in giving you a plate occasionally for your Zoophyta, but I trust you will see that the drawing reaches in time to afford you proofs. Zoophytes are, as we both feel, interesting objects, but we must not forget your *crag, alluvium,* &c., which you promised to give me some day soon. These subjects being more in unison with the temper of the time than *Sertularia,* &c. It was reported here, that you were to be settled for a time as Principal at St Andrews, and it may still be the case, for Dr Lee is by no means clear as to what he may do. This would bring you nearer the capital, where you may ultimately rest."

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* *Tourmaline.*

Neither Dr Fleming's earnest wishes for removal from Flisk, nor the family afflictions of his last year there, nor the absorbing work connected with his removal to Clackmannan, had, in any way, tended to beget distaste for those purely scientific pursuits in which he had made himself a name. In 1830, he contributed to the Wernerian Society, papers, "*On the occurrence of Scales of Vertebrate Animals in the Old Red Sandstone of Fife,*" and "*On the Superposition of Strata on the banks of the Tay.*" To the Edin. Phil. Journal he forwarded a trenchant "*Reply to Macleay's Attack on the Dichotomous System.*" In 1831, he sent to the Magazine of Natural History, "*Observations tending to establish the identity of the Deal Fish of Orkney with the Vaagmaer of Iceland.*" From Aberdeen he wrote to Professor Jameson "*A Notice of the remains of a Fish found connected with a bed of coal at Clackmannan.*" Little more than a year before he had left that place, where some of the happiest days in the work of the ministry had been passed; and that he still cherished a lively remembrance of the cordiality of the people, is prettily shewn in this communication. "As M. Agassiz," he says, "is at present successfully occupied in the description and classification of fossil fishes, and may probably be enabled, satisfactorily, to establish a genus to which the present organism may be suitably referred, I feel inclined, provisionally, to denominate it ICHTHYOLITHUS CLACKMANANENSIS*—a designation suggested by many pleasing recollections of kindness which I experienced while resident in the district." He adds—.

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* *Megalichthys Hibberti.*

> "When this organism was first exhibited to me, I was at no loss to recognise the resemblance between the plates or scales with which it was invested, and which occur in natural juxtaposition, and objects of a similar form and structure, though detached, or unconnected, which, twenty years before, I had procured in the county of Fife, from a bed covering the Marine or Mountain Limestone on which the coal-formation of that district rests as its fundamental rock. As the consideration of the form, structure, and composition of the organisms from Fife had induced me to consider them as *the scales of a fish*, I was led, under the influence of this opinion, and observing the scales of the Clackmannan petrifaction occupying both sides of the specimen, to seek for traces of the appearance of the vertebral column, and I soon satisfied myself as to the indications of its existence at both extremities of the mass. In this conviction, I despatched the example to Edinburgh, with directions to the lapidary for making a section confirmatory of the views of its nature which I entertained. When in the hands of the lapidary, it was inspected by several members of the Royal Society of Edinburgh, whose zeal in the study of organic remains had received a fresh impulse from the numerous specimens which had been found in the limestone of Burdiehouse. In the opinion of more than one member of the Society, labouring at the time under *saurian* or *sauroid* prejudices, my specimen was pronounced to be the fragment of a reptile, not of a fish."

In 1837, he contributed the well-known article *Mollusca* to the seventh edition of the Encyclopædia Britannica. Dr Fleming was much gratified by a visit from Agassiz and Dr and Mrs Buckland in 1840. The visit of the Swiss Naturalist enabled him to compare notes on the fishes of the Old Red. Agassiz saw at once, that however much might have been done in that field by other labourers, Fleming had the merit at least of being the first to discover in it the remains of fishes. And he was not slow to acknowledge this. "C'est," he remarks in his magnificent Monograph on Fossil Fishes, "sans contredit au célèbre Professeur d'Aberdeen (M. le Doct. Fleming) qu'est due la première decouverte de poissons fossiles dans le terrein devonien." The visit of Dr Buckland also tended to remove entirely every trace of the misunderstanding which had sprung out of the Deluge controversy, and it led to a correspondence which was kept up with great spirit for years by that eminent and good man.

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logy—though, strange to say, he makes no mention of Moses and of Jameson. The former he omits through prudence. I fear that the Edinburgh school has sunk to rise no more. Wernerianism is being universally admitted to be a humbug, and harmony and co-operation in Auld Reekie unknown." "I have just received another letter from Mr Murray of London, beseeching more contributions for the *Quarterly,* and a series of vols. for the *Family Library.* I intend to send soon another antiquinarian broadside." His intimacy with his friend Mantell was becoming closer. In August 1832, Dr Mantell wrote:—

"My Dear Sir,— . . . How I wished for you at Oxford! It would have been glorious to have had you there. Had you and Lyell been there my happiness would have been complete, for there were almost all the naturalists and sçavans of Great Britain besides. I spent a week there, and afterwards went to Bristol, crossed through Somersetshire to Lynn Regis, sailed to Isle of Portland, and returned home by Weymouth and Southampton, after one of the most delightful trips I ever had. I brought home a good *Plesiosaurus* with me, and lots of silicified woods, from Portland. But I have since made a grand discovery in my own territory, a considerable part of the skeleton of a reptile (I hope *Iguanodon*) in Tilgate Forest. In a block of stone, 4½ feet by 2½, and weighing nearly 3 cwt., are imbedded ten or twelve vertebræ, with ribs, coracoid bones, chevron bones, &c., and what I have never observed before, lenticular bones of so peculiar a structure that even fragments may be easily detected. I think they must be *dermal* bones to support the scales. But as I shall draw up an account of this wonderful fossil, you will then see the details, and I need not trouble you with farther observations now.

"For your admirable remarks on the shells of the Wealdon I am indeed most deeply indebted, and can never make an adequate return for your kindness. The greywacke specimens were of great interest to me, and filled up a drawer in my geological suite that had long been empty. I am still in want of good specimens (for my *rocks*) of *Transition Limestone, Trap, Basalt,* and a good suite of the beds of the *Coal Measures.* Although I am unworthy of your prompt attention, yet I would beg a few lines as early as possible to tell me how I shall send the box; and I would beg to know what fossils you are most desirous of having from the south. I have no list, and but a very imperfect recollection of what I have already sent you, and therefore must entreat you will oblige me with a few hints of your desiderata.

"I have lately received a fine suite of American *recent* shells, principally

the Naiades of their glorious rivers; there are a few duplicates of their Uniones, &c.—would you like any? This is our assize time as you will perceive by Lord Tenterden's frank, and I am hurried with company, and must write very desultory. I have discovered a species of *Hippurite* in the Lewes Chalk—the first found in England, is it not? so they allowed at Oxford. Of my reptiles, I have found some very splendid detached bones; but in one block of stone I have four bones of the toes, the longest, 7 or 8 inches long. But the greatest puzzle is a bone which even Cuvier could not guess at. It must be a clavicle I think from what I have lately found; and yet so odd is it, that Clift said the only bone at all approaching it, and that at an immense distance, is the first rib of the ostrich. . . .

"I am vexed to conclude so abruptly, but I cannot avoid it, for judges, barristers, clients, jurymen, and all are determined to call me away.

"Do shew me, my dear Sir, that you have not forgotten me; and let me have the pleasure of knowing that I can send you something that will interest you.

"With the highest esteem and respect, and sincerest wishes for your health and happiness, I am, my dear Sir, most sincerely yours,

"Gideon Mantell."

The last communication from Dr Mantell is full of melancholy interest. He had left Brighton and taken a house at Clapham Common, and here the "shadows of life" began to creep over his frank, manly, generous nature. Many of his dearest hopes blighted—stricken by a severe paralytic affection in his lower limbs—obliged to part with his magnificent collection of fossils for £4000, not half of the sum it had cost him,—the loveable old man writes to his sympathising friend in Scotland, tells him of these and of other ills to which flesh is heir, and adds, "So much for the shadows of life, yet the brightness has not been inconsiderable."

Much came of the movement in Dr Fleming's behalf at Auchtermuchty. The patron did not, indeed, grant the petition of the whole parish, but the thought that so many people, who were well acquainted with his manner of life as a minister of Christ, had earnestly sought to put themselves under his care, had greatly cheered and encouraged him. Fresh impulses were given to pastoral work, and the very excitement of the circumstances gave new and vigorous direction to his energies. Yet the desired change was at hand. In August of the

"It is gratifying to me to know that you think so highly of the character of the series of works on the Natural History of the British Islands, now in course of publication; the second edition of the Fishes has now been for some weeks past before the public, and the Birds of which you have an example herewith, have a very extensive sale. I am, my dear Sir, yours very truly, "WM. YARRELL."

Mr Selby returns answer:—

"Twizel-House, Jan. 17. 1842.

"My Dear Sir,—I feel quite ashamed when I look at the date of your letter, to find that I should have allowed it to remain so long without an answer, but the very day on which I received it, I left home for London. Let me now thank you for your paper containing the description, &c., of the curious skate found upon the Aberdeenshire coast, an earnest I hope of the renewed interest you feel towards natural history pursuits, for which department of science you have already done so much. Whether the carrion crow and hooded crow of Fife and Aberdeenshire constitute but one species, I will not venture to determine, but of this I feel perfectly certain, that the carrion crow of England, common in this part of the country, is a species perfectly distinct from the hooded or grey-backed crow, which only visits us during the winter season. The habits of the one are quite different from those of the other, and they are very rarely seen in company together. The hooded crow keeps generally near to the coast, where it often associates with the rook, feeding upon marine animal matter, as well as upon the refuse of the dunghill, &c. The carrion crow very rarely resorts to the coast, but keeps more inland, and affects our woods and plantations, and out of hundreds that for the last thirty years have been bred in my own woods, I never knew an individual that assumed anything like the livery of the hooded crow."

Professor Sedgwick acknowledges the receipt of the Description:—

"Cambridge, April 13. 1842.

"My Dear Sir,—I have this moment received your kind note, and your essay upon an *odd fish*, for both of which I warmly thank you. Your friendly expressions delight me; for I have always regarded you a good man and true, who had toiled hardly and successfully in the cause of truth and knowledge. Of such a man I shall, I trust, ever continue to value the friendship very highly. I wish your engagements permitted you oftener to move southwards. We now have something worth looking at. A new Geological Museum, in which we can make a show of our underground riches, and a fine collection of comparative anatomy, brought together during the superintendence of our present Professor, Dr Clarke. Owen of the College of Surgeons, has been here several times, and thinks much of both our collections."

His friend Dr Johnston was not less prompt :—

"*Berwick-upon-Tweed, Nov.* 17. 1841.

"Dear Sir,—I feel particularly gratified and pleased by the receipt of your kind letter. Allow me to thank you for it, and for the friendly criticism it contains, and, to conclude this part of my business, I will also thank you for the paper descriptive of the curious skate, and for the specimens of the sponges.

"I have not yet had leisure to make a full examination of your *Cydonium*, but enough to satisfy me of its nature. It is an object of much interest, and the type of a genus new to Great Britain. There is no doubt in my mind that it is in fact a species of *Geodia*. This genus has been inaccurately characterised by Lamark, but Milne-Edwards has described it well. I do not find that he has characterised any species, of which he seems to know several. The *Alcyonium primum di Dioscoride* of Donati, is one, perhaps different from yours, though it is not easy to say. Your description appears to me to have been made partly from Muller's and partly from your own specimen, but as *Geodia* is a sponge, it can have no polypes, neither can it be Muller's *A. cydonium.* I have again looked at the figure of this, and notwithstanding all you urge, I remain in my old opinion. The next time you get an orange variety of *Lobulari,* put it into a glass jar, and after an hour or so, you will see *Alcyonium cydonium* as like to Muller's figure as ever Viola was to Sebastian.

"The *Tethea* I sent you is your *Tethea sphærica*—the *Spongia verrucosa* of Montagu. It varies a good deal in wartiness. I have seen it quite smooth.

"Mr Bowerbank is making wonderful discoveries in the structure of sponges. The *Spongia fragilis* of Montagu I had made the type of a new genus—*Dyseidea ;* but perhaps I scarcely understood the structure at the time. However, Bowerbank adopts the genus. I wish I had my work on Sponges to rewrite. I have murdered the subject. I trust you have seen Yarrel's new edition of his Fishes ; he has not your skate.

"From the kind manner in which you have offered me your assistance, I shall not hesitate to apply to you on some future occasion. I can only say, that whatever I can do for you in the way of sending specimens, &c., any I have is at your service. I do wish you could resume your Natural History labours. We have a lack of naturalists of your calibre and extent of views ; there are enow of the genus to which your humble servant belongs. I am, dear Sir, yours very respectfully. GEORGE JOHNSTON."

While they rejoice in their friend's return to Natural History, it is not uninteresting to notice how quickly each hastens to his own favourite line of study—Yarrel and Selby to Birds, Sedgwick to Geology, and Johnston to Zoophytes.

CHAPTER VI. 1843 to 1845.

East Coast Harbours of Refuge — The Disruption — Threatened Expulsion from the Nat. Phil. Chair—Letter to Dr Chalmers—Prospects—Scheme of a New Chair for Natural Science—Chalmers' Views on the New Chair —Letters of Chalmers—Dr Welsh—Inverness Assembly—Appointment to New College Chair of Natural Science—Anxiety about the future—Movement among the Laity—Letter from James Cunningham, Esq.—Resolutions—J. Bonar, Esq.—Dr Duff.

THOUGH, as we have seen, Dr Fleming was very far from indifferent as to the issues of the ten years' conflict in the Church for spiritual independence, and though he saw clearly that his own position as a Professor in one of the National Universities, over which the Church to a certain extent had control, might be endangered, he was yet found calmly working at his favourite pursuits. His energies, however, were not directed to science alone; they took a direction social rather than scientific. His residence at Aberdeen had made him acquainted with the loss of life that yearly occurred on the East Coast, for want of safe harbours into which vessels might run when overtaken by a storm. He threw his characteristic energy into this; and having extended a short paper which he had read to the Aberdeen Phil. Soc., it was communicated to the Edin. New Phil. Jour., under the title, "*On the Expediency of forming Harbours of Refuge on the East Coast of Scotland, between the Moray Frith and the Frith of Forth.*" In the opening of this useful paper, he says:—"That no public inquiry should have been instituted respecting the exposed state of the East Coast of Scotland, with a view to the formation of Harbours of Refuge, when it was granted elsewhere, may seem inexplicable, unless we bear in mind that lamentable apathy exhibited by our representatives in Parliament, whenever

Scottish interests of a *general* character is concerned." Before indicating the most suitable sites for harbours of refuge, he brings his geological knowledge to bear on the question, and points out the localities to be avoided. The places at which rivers reach the sea, are shewn to be least convenient for such purposes. "When we examine a Valley of any extent with the eye of a geologist, we generally find that the rocks which exist in its trough, are softer and more easily acted upon, than those which form the boundary ridges. . . . . . The valleys necessarily form the recipients of rain water, and constitute river basins ; and the rivers thus formed by them, and flowing through, serve, in turn, to augment their capacity, by carrying to a lower level the disintegrated materials which have been produced by atmospheric influence. These materials become accumulated at the junction of the river with the sea, and constitute, in certain cases, those *deltas* which frequently occasion a subdivision of the main stream." These remarks are fully illustrated, and the localities pointed out that seem best fitted for harbours of refuge. Some attention has already been paid to this subject by those interested in our marine, and it is to be hoped that the views thus brought out by Dr Fleming, in the spirit of patriotism and philanthropy, will not be lost sight of by our Scottish representatives, many of whom are now not indifferent to the *general* interests of the country.

Dr Fleming joined the Free Church at the Disruption. As he had expected, his position in King's College was threatened, and he was a good deal annoyed by daily rumours of action being about to be taken by the Established Church, against all the professors in the different Universities who had identified themselves with the Free Church. St Andrews was forward in this work. The steps taken there against Sir David Brewster, and the indignation which they called forth among the leading minds of Britain, are well known. Dr Fleming received information, which he believed perfectly trustworthy, that immediate steps were to be taken, which would present to him the alternative either of resigning his chair in King's College, or of conforming to the Established Church. He was unwilling to encounter the trouble and irritation, believed to be unavoidable, if he should try to hold good his position as Professor of Natural Philosophy. It was also felt by him somewhat discouraging, that, after all he had done for science, he should be driven from a chair, the efficient occupancy of which could in no way be interfered with by his opinions on matters of church government. These providences, however, gave weight to views which he had long entertained regarding the duty of the Church towards natural science. Might not that be a fit opportunity for stating these, and might not the Free Church realize a professorship for teaching what he had long held to be a great desideratum in existing academical education? These things led him to open his mind to his old friend Chalmers. In a communication to Dr Chalmers, dated "King's College, August 18. 1843," he makes him fully acquainted with the bitterness of ecclesiastical feeling towards him—shews the likelihood of his having to leave King's College, and brings out his views as to future work. The correspondence between Dr Chalmers and him at this period is very full of interest. The letters of Chalmers are peculiarly characteristic; they are shrewd, frank, generous, and absorbingly hopeful of the future, not for his friend only, but for his beloved Church also. Only a few extracts can be given here, and such passages are selected as set in a true light Dr Fleming's appointment to the Chair of Natural Science in the New College, and his views of the nature of such a chair. Dr Fleming writes:—

"Now it becomes a measure of necessity to look the evil in the face and provide against it, especially after what has taken place in the House of Lords. . . . . I might recommence preaching, and, although an old razor and rather rusty, I might yet get a call and be usefully employed. But while I labour under the conviction that in such a station I could not do *much good* to the Free Church, I have strong bodily and mental objections to such a course, as you may easily conceive, after having been nine years absent from a parish charge. Were a Free Church College started in Edinburgh, I could, in the Chair of *Natural History*, bring an amount of influence in that department, in which I formerly published a good deal, likely to be highly useful to the Institution. Were a Chair of *Natural Theology* attached to the Divinity Hall, I think I could occupy it with considerable advantage to the Free Church. For the sake of example, let us suppose that a three years' course has been determined upon, what should be the subjects discussed and the expedient order of procedure. I would propose the following :—

"*First Year.*—The Inorganic Kingdom. The earth as a part of the Solar System, depending on its position for its heat, light, and the force of gravity, as laying the foundation for the proof of adaptation of the states exhibited by its inhabitants, animal and vegetable. The few elementary substances, and the laws observed in the formation of the mineral species. (Had Paley been conversant with this subject, he would have avoided a gross blunder in *stating his argument* in his Natural Theology.) The laws respecting the constitution of masses. The character of the air and waters. The composition and arrangement of the strata, the formation of soil, and the relation of the states of the globe to the condition of vegetable and animal life.

"*Second Year.*—Biology, or the common properties of living beings. Phytology, or the structure, functions, and distribution of plants. I would not exclude the modes of learning the *names* of plants, *usually called Botany*, but, at the same time, chiefly attend to the laws of vegetation, laws which constitute the first principles of gardening and agriculture.

"*Third Year.*—Zoology, in the mode treated of in my Philosophy of Zoology.

In thus giving an outline of a course of Natural Theology, I am assuming that the subjects for consideration should be confined to those susceptible of illustration by ocular or tangible proof, for such I consider exclusively suitable. Such a course would qualify for conversing with farmers, miners, fishermen, &c., not merely by a knowledge of facts, but by an acquaintance with the philosophy of the subject, and, viewed in this light, it would give a certain amount of authority, as you are well aware, to a parish minister. But to a missionary what a power would be acquired . . . . I need not expatiate to *you* on the influence which such a course would exercise on the minds of the students of the Free Church, or the power of pulpit illustration which it would furnish. Multitudes do not see God in his works because they are not qualified to read the book of nature. They have not studied the subject sufficiently in its details to philosophize safely. Now were the facts sufficiently numerous and varied in their character, the conclusions would be useful and stable. Such a course would supply to the divinity student the place of classes of Mineralogy and Geology, Phytology and Zoology, and constitute a theological commentary on the earth, its contents, and inhabitants. . . . . I beg of you, in judging of this scheme of a Natural Theology Chair, to keep *me* out of view, and to determine respecting it wholly as a new branch of educational preparation exclusively *on its own merits.*

It seems to me that every one possessed of average intelligence, and alive to the necessities of the case, even though uninstructed in the branches here referred to by Dr Fleming, must be struck with the admirable character of this outline, and be ready to acknowledge the value of such a *Theological Commentary on the Works of God.* Nor can there be any doubt but that this, under a different name, Natural Science, was substantially the sketch which he filled in, as Professor in the New College.* It is true, there were many alterations and modifications, but these were introduced in order to meet current phases of unbelief, and of aberration from the safe platform of inductive Physical Science. The scheme, as might have been anticipated, took a very strong hold upon the great mind of Chalmers, who writes to him immediately (Aug. 31) from Dunkeld :—

"My Dear Sir,—I am thus far on my way to Aberdeen, which I expect to reach on the 4th of September. Your truly important letter was sent forward from Edinburgh, and reached me yesterday. I have been much interested by its contents, which have given great occupation to my thoughts —insomuch, that I will forbear any adequate conveyance of my views till we meet. Meanwhile, I may state generally what at the moment occurs to me. . . . . Your letter has suggested a most useful Professorship— one of the Natural Sciences in subservience to Natural Theology. . . . . I find that I must postpone till we meet the views I have to offer on the difference between your course being one of three years, or one of a single year. I fear that the former method would not harmonize with the working and right consecutive order of the other theological classes. But I must not venture on this complication at present. Suffice it to say, that I am exceedingly interested by your letter, and look eagerly forward to full and repeated converse with you on its highly important subject. It has given me the glimpse of what I feel to be a large and beautiful perspective which I think might, with a proper degree of exertion and skill, be fully realized. I ever am, my dear Sir, yours most truly, "THOMAS CHALMERS.

"Dr Fleming.

"I beg my best regards to Mrs Fleming."

The letter is what might have been looked for from such a man on a subject of this kind. He saw at once what advantage this chair might be, not to the Free Church alone, but to the cause of Christian science. He read the signs of the times aright—saw the rising general taste for geological and zoological studies—observed the direction which the highest thought of Britain was taking—and felt that it was of great moment that the ministry of his church should be abreast, or even ahead of the leading phases of thought in their day, as they had been found in by-gone times. When Fleming and Chalmers met at Aberdeen (Sept. 1843), a definite understanding was come to as to the sphere of the new professorship, designed to meet a want now distinctly recognised, and Dr Fleming was asked to draw out a plan which might be submitted to Dr Welsh. "In order," says Fleming, "to do justice to such a course unquestionably more than one session would be required; but bearing in mind that among things desirable, the practicable must have the preference, I fear that more than one course would not be thought of or encouraged at the present time." The scheme forwarded is the same generally as that indicated in his first letter to Dr Chalmers. It is much simplified, however, and put in such a shape as might come fairly within the lecturer's reach in one year. It is divided into two parts—the secular foundation, and the theological application. The former being designed to include lessons in natural science, strictly so called, and the latter, all the points of special interest to the natural theologian—as adaptations between structure and functions—the exhibition of a plan in the order of nature, &c., and the application of natural history to the illustration of scripture. Dr Welsh entered cordially into his plans, and informed him that his paper would be of "much value to him in the College Committee;" and Dr Chalmers wrote:—

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* See Dr Fleming's *Institutes of Natural Science*, 1845.

"Your letter came to me at St Andrews, since which I have been in an incessant bustle. I am only an hour in Edinburgh, and gladly avail myself of the first leisure for a reply. . . . . . Sir David and I both exceedingly admire your scheme of a professorship. I will transmit it to Dr Welsh, who is still in the country. I go to near Biggar, where my son-in-law is, for indispensable repose, for a week. When I return we shall have frequent meetings of the Education Committee, when I am confident all will hail the prospect of such an accession to our educational system as you propose; and in particular, of yourself as the head and conductor of it. . . . . Do give my very best and kindest regards to dear Mrs Fleming, and to you, sir, I cannot express how much I sympathise with you in the midst of your difficulties; but by the blessing of God on a clear, open, and resolute course of acting, I have the confident hope that you will prevail over them."

In his answer to this communication Dr Fleming asked :—

"*Would such a chair as the one we have been contemplating be a useful accession to the educational system of the Free Church?* Sir David agrees with you in admiring it. If the Educational Committee be of the same mind, its institution may be considered as determined on. . . . . The question, *who shall fill the chair?* is the one which involves *me* in the greatest difficulty. Years ago I would have publicly advocated the institution of such a chair, if I could have detached myself from the charge of manufacturing a place for myself. Recently the subject came above board incidently here, and as there was a prospect of my being driven from the university, or the Free Church requiring a separate university, the subject of the chair of natural history was mentioned, when I stated the kind of chair which would be most needed, and which would prove of the greatest service to the Free Church. . . . . Were I fairly off the field I could proclaim my views without reserve, and thus pave the way for the institution of a chair and its occupancy, when these things shall have ceased to interest me. Even though the matter should take end here, which is very probable, from the number of conflicting elements, I shall have the satisfaction of knowing that the attention of other minds has been called to the subject."

Dr Chalmers intimated to him that it had been resolved, not to make any appointment for a year at least, and expressed regret, as he feared he would be much disappointed. In his answer Dr Fleming acknowledges the expediency of this delay, but points out that if he had suggested the chair, the step had been taken on the merits, and not with any desire that a position might be made for him individually. He asks his friend to put the Committee right on this point, if any one of them had entertained the thought. To this Dr Chalmers hastened to reply:—

"I beg to assure you in the strongest manner, we have never once looked to the question in any other light than as a public question; and that in that view we hold a class of natural science in connection with theology to be most desirable as a component part of our system of theological education. . . . . Let me again assure you that both I and they, on scientific grounds alone, and exclusive of every other consideration, look forward with the utmost desirousness to such an addition; and though there is but one opinion, that you are the person to whom we all should look for taking the chair, it is to your qualifications alone that we look, and never even to your present interest or conveniency."

It has seemed good to enter thus plainly into the nature of this chair, and the circumstances attending its institution, because great ignorance prevails regarding both, and I have frequently heard statements made reflecting on Dr Fleming, unwittingly no doubt, as if the professorship had been instituted for reasons personal to him, and not as something which was to hold a permanent place in the Church's theological system of education. It is to be hoped that the above extracts will set these questions at rest, in so far as the origin of the chair and Dr Fleming's connection with it are concerned.

The appointment was made at the Inverness Assembly, August 1845. Dr Fleming was residing at Culloden House, whence he wrote to Mrs Fleming :—

> "The result of the conference (or private Assembly) in my case was so very flattering that I cannot give you the details. I really hope that little will be said when brought before the House. I can stand abuse, but flattery is not congenial. I feel the importance of the chair in so many respects that I wish I were quietly at home to give it the grave consideration which it demands." "I have just returned from the Assembly at half-past twelve at night; but before going to bed must tell you that the appointment was sanctioned by the Assembly with acclamation. Altogether the thing has taken place harmoniously, and in a very flattering manner."

As Professor in the New College, he found himself in a position to give free scope to his great talents as a teacher of Natural Science. And, perhaps, it is not putting the matter too strongly to affirm, that, notwithstanding all the ability he had shewn as an author, he was now in circumstances to do more for the beloved pursuits of fifty years, than he ever could have done through the press alone. He could inoculate the rising mind of the Church with his own strong love for the study of nature, and thus send forth his students to do for others what he had done for them. But time brought with it trials connected even with the chair which he filled with so much ability and success. Two lay chairs had been instituted, one for Moral Philosophy, the other for Mental Science. These, which had been taught with very great ability and success by Professors Macdougall and Fraser, were not filled up when the Professors were elected to corresponding chairs in the National University. Then, the abolition by Parliament of Tests for lay professorships, seemed to raise the questions, If the Church has learned to do without the other two, is there any need for the maintenance of one for Natural Science? And, Is there any specialty to be alleged for upholding it? Dr Fleming saw that these questions had come to be entertained, especially by many in the ministry of the Free Church. He might have been saved the annoyance resulting therefrom, had the ministry been made aware of the true nature of the chair, of the views of Chalmers and Welsh concerning it, because, in the full and frank statement of these things, it would have appeared that the circumstances which came to influence the other two, had, in reality, no bearing on his. So strongly, however, did these things move him, that he resolved to appeal to the laity of the Church, as being fully aware of their high appreciation of the importance of his Chair. This he did in a letter to the *Witness* newspaper, and he had good cause to be satisfied with the result. Many, both in the ministry and among the laity, resolved to rally around him, and to realize his desires, touching the chair in which he was so deeply interested. To the *Witness* of Saturday, February 28. 1857, he writes :—

"When, in my communication of date 28th October 1856, I ventured, after much hesitation, to direct the attention of the friends of the Free Church to the prospects of the Chair which I have the honour to occupy, I was oppressed by very gloomy forebodings as to its permanency. Soon, however, a considerable measure of relief was afforded by the reference to the class in the 'Interim Report on the Training of Students of Theology,' as submitted to the last Commission in November, and by the remarks which fell from the Convener and Dr Candlish. More recently, the judicious views of Mr Fraser and his colleagues, in the Presbytery of Paisley, with the overture to the General Assembly, in which these are expressed, yielded a fresh amount of encouragement. But both these proofs of a growing interest in the subject appeared to be surpassed, when the following letter and document were put into my hand yesterday. The laymen who have subscribed the resolutions (whose designations have been added since) are qualified from their positions and attainments to give a trustworthy opinion on the interesting question, and have stated their views with distinctness. I shall merely add, that I feel grateful to all who have expressed

sympathy or indicated co-operation, and desire to thank God and take courage.
"JOHN FLEMING.

"*New College, Edinburgh*, 25*th Feb.* 1857."

"*Edinburgh*, 23*d Feb.* 1857. 50 *Queen Street.*

"My Dear Sir,—I have much pleasure in enclosing a copy of the resolutions which have been adopted by some laymen of the Free Church, who take a deep interest in the Chair of Natural Science in the New College; and remain always, with much respect, yours most sincerely,

"JAS. CUNNINGHAM.

"Dr Fleming, New College."

"We, the Subscribers, Elders and others, Members of the Free Church of Scotland, having carefully considered the facts stated in a letter issued by Dr Fleming in October 1856, entitled, 'On the State and Prospects of the Chair of Natural Science in the New College, Edinburgh' (appended hereto), and being also otherwise deeply impressed with the importance, especially in the present day, of the permanent maintenance of the Professorship of Natural Science in the New College, Edinburgh, and cordially concurring in the views publicly urged to that effect by Dr Chalmers, Dr Duff, Dr Candlish, and others,—

"RESOLVE,—1. That we form ourselves into a Committee for the purpose of using our best endeavours to secure that the Chair of Natural Science shall be made part of the curriculum in the New College.

"2. That in the event of any movement being made to endow the existing Professorships in the New College, we shall use special exertion to secure the maintenance of the Chair of Natural Science.

"3. That Mr James Cunningham be requested to act as chairman, and to convene the Committee thus formed, whenever it may seem necessary.

"4. That it is proper that Dr Fleming should be apprized of the movement, and that with that view, a copy of these resolutions be forwarded to him, whenever they are subscribed by twenty individuals.

February, 1857.

(Signed) "Sir THO. MAKDOUGALL BRISBANE, Bart., G.C.B, &c., &c., President of the Royal Society, Edinburgh; P. DALMAHOY, W.S., 69 Queen Street; JAMES TOD, W.S., F.R.S.E, 55 Great King Street; Sir GEORGE SINCLAIR, Bart., of Ulbster, 42 Charlotte Square; JOHN M. M'CANDLISH, C.A., 18 Moray Place; JAMES R. DYMOCK (Councillor), 30 Buccleuch Place; CHAS. JAS. KERR, Banker; J. G. WOOD, W.S., 52 Melville Street; JAMES RUSSELL, M.D., F.R.S.E., 15 Lynedoch Place; JOHN MELVILLE, W.S., F.R.S.E. (the Right Hon. the Lord Provost), 15 Heriot Row; ALEXANDER BRYSON, Prince's Street; THOMAS CONSTABLE, Printer to her Majesty; A. KEITH JOHNSTONE, F.R.S.E., and Geographer to the Queen; **Robert Allan**, F.R.S.E., York Place; **John Geddes**, Mining Engineer, Shandwick Place; **James Dalmahoy**, H.E.I.C.S., and F.R.S.E., 9 Forres Street; Colonel **Geo. Cadell**, H.E.I.C.S., 13 Randolph Crescent; **Robert Paul**, Banker; **Jas. Miller**, Professor, F.R.S.E; **Jas. Cunningham**, W.S., F.R.S.E., 50 Queen Street; **Alexr. Thomson**, F.R.S.E., Banchory House; J. Y. **Simpson**, Professor, F.R.S.E; **Andrew Jameson**, Sheriff-Substitute, Edinburgh; **Robert Morrieson**, H.E.I.C.S., F.R.S.E.; Colonel **Hugh Morrieson**, H.E.I.C.S.

After the tidings of Hugh Miller's death reached India, Dr Duff wrote a most earnest appeal to the admirers of Mr Miller, and to the friends of science in Scotland, suggesting that Dr Fleming's chair should be endowed as the Miller Chair of Natural Science. Such a monument to this great man would have been a becoming one. But were the friends named above desirous to do honour to two of the greatest sons of the Free Church, they have the opportunity offered them by raising an endowment for a "Miller and Fleming Chair of Natural Science." The monument would be one of the noblest that could be raised to their memory.

Greatly cheered by the memorial from the laymen, Dr Fleming ceased to think of his own feelings in connection with the chair, and set about, in great earnestness, to have the Natural Science Professorship endowed. He had too much shrewdness, and too correct an estimate of the prevailing ignorance of the value of the chair, not to see that its continuance might come to depend upon its endowment. "You well know," writes his friend, James Bonar, Esq., "how intensely interested Dr Fleming was, not only in getting the chair instituted, but in having it placed on a permanent basis. Often he regretted the apathy which he feared was beginning of late years to pervade the Church in regard to it; and he laboured earnestly to prevent the possibility of its being suppressed in the event of his removal."

Dr Fleming's death put a stop to this movement, which promised to be of so much advantage to the Church and to Christian science.

CHAPTER VII. 1843 to 1857.

Correspondents—Edward Forbes—Dr Buckland—Sir Roderick Impey Murchison—Sir Charles Lyell—Lord Cockburn—Dr Welsh—North British Review—Contributions—British Association—Royal Physical Society—Conclusion.

Dr Fleming's appointment to the New College Chair of Natural Science, put him in circumstances both to throw all his strength into its proper work, and also to help on the progress of science by corresponding with others, who, like himself, were working enthusiastically in favourite departments of Natural History. In this latter aspect of work many cordial testimonies were paid to him by the greatest of his contemporaries. Of these, that rendered to him by Professor Edward Forbes is, for many reasons, full of interest. Seldom could two men be found who, while they had so many points in common, differed so widely in regard to many more. Both from early youth pursued the study of nature as with the force of a ruling instinct. I once heard Forbes say, "it would not be believed if I told how soon I began to collect fossils;" and among Fleming's papers there are boyhood jottings on birds and beasts, fossils and flowers, which bear evidence of shrewd observation, and of discrimination beyond his years. Both were true field naturalists—men who told what they saw as they waited on nature in the forest, by the shore, far out on the "open sea," or amidst the solitudes of the everlasting hills, and won from her secrets which she tells to none but single-hearted devotees. Both held that an acquaintance with the literature of science is second only to attainments in science itself; and both were profoundly conversant with the workers that had gone before them in kindred fields of research and discovery. But the contrast stands out in bolder relief than the comparison. Forbes' disposition was naturally lively (*animé*); Fleming's was grave (*sévère*). The one ever brought the "bodying imagination" of the poet into his studies; the other stood in doubt of every thing that could not stand the stern logic of inductive philosophy. Forbes loved to give way to sallies of wit, in which intellect sparkled like wavelets under bright sunlight; Fleming's humour passed into sarcasm, and many of his happiest hits in social intercourse had "a sting in their tails." The former loved theories, and ever saw facts with the generalizing eye of the poet; while the latter eagerly treasured up facts, he regarded with great suspicion every attempt to make any one of them tell a different tale when associated with other facts, from what it plainly said when standing alone. And because Forbes had made known so many new facts, Fleming was strongly drawn to him. But they could never have thoroughly understood each other. This is frequently illustrated in their correspondence. Besides, it is too often with students in the same departments of science, as with bodies under the law of chemical affinity, like does not draw to like—alkalis to alkalis. The union only becomes complete when alkalis meet antagonistic acids. There can be no doubt however, that Fleming had, in many things, the advantage of the younger naturalist. While Forbes, even in his chosen sphere of excellence, was not unwilling to be indebted to the Scottish naturalist; Fleming left him far behind in other branches of zoology, and especially in his knowledge of the highest philosophy of the sciences. Had Forbes' life been spared, he would have passed beyond all these deficiencies. That two such men should have, for a time, taught in one city the same branches of science, has not been sufficiently noticed. Never may Edinburgh hope to possess such a union again in the instruction of youth in natural science.

The value of the following notes will at once be seen by all who are interested in Dr Fleming's fame:—

"6 *Craig's Court, Charing Cross, London*, 12*th April* 1848.

"Dear Dr Fleming,—You are probably aware that I, in conjunction with Mr Hanley, am at present engaged on a History of the British Mollusca.

Your 'British Animals'—long my text-book as a student, and still always by my side—has often to be consulted in the course of our work. Will you allow us to put two or three queries respecting some of the species therein enumerated?

"1. As to *Tellina fragilis* (p. 434). The description does not agree with the Linnean species. What is your shell?

"2. *Cardium muricatum*—Dr Coldstream's* specimen—with thirty-seven ribs, and compressed—instead of *ventricose with thirty-two ribs*, the usual character. Is Dr Coldstream's shell an exotic one, and if so, what species in present nomenclature?

"3. *Cardium serratum* from Pentland Firth; you give it as Turton's shell, which, however, is only young *C. lævigatum*. Is yours distinct?

"Pardon these queries, which are asked from the wish to do all possible justice to those who have laboured so well before us. And believe me, Dear Dr Fleming, most sincerely yours, "EDWARD FORBES."

"6 *Craig's Court, Charing Cross, 19th May* 1848.

Dear Dr Fleming,—I have to acknowledge the receipt of your kind letter and the shells—both very interesting. The *Cardium muricatum* is the true Linnean species of that name, but is a foreigner, probably South American.

"The '*Tellina fragilis*' appears to be a *Thracia*, and a very curious one, not known to either Hanley or myself, so far as first glance can tell. May I venture to ask for a note respecting its locality, as you do not state any particular place for your specimens of it in the British Animals? Can it be an Arctic shell?

"The mistake about the *salpæ* was some bungle on my part entirely, not however from trusting to memory, for I had the paper at hand. I must try and find out how I made the blunder; but wont plead guilty to having neglected the paper.

"I hold to the distorting power of fresh water on *Mya arenaria*, and on many other marine mollusks, as I shall have occasion to shew hereafter. Moreover, I venture to think that I could convince you by a few plain prose arguments, backed by specimens and facts in plenty, and without the aid of 'poetry.' But what seems *poetry* to you, is received as *prose* by some; for the same post brought your protest against my harmless attack on teetotalism, with a letter from another, and also very able quarter, assenting to and teaching it!

"If at any time in our Mollusca book we appear not to give you full credit, or rather due credit, dear Dr Fleming, I trust you will believe it unintentional, and I will be much obliged for any correction. There is always the preface and historical introduction at the end to do justice and repent in. When I say that all my knowledge of British Natural History was based upon your works—the British Animals having been my text-book and constant companion as a student—I speak sincerely, and write privately now, what I mean another time to put forward publicly, with reasons why. Ever, dear Dr Fleming, most sincerely yours,

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* One of Dr Fleming's oldest and most intimate friends; a skilful physician—accomplished naturalist—and one highly esteemed as a Christian philanthropist.

" EDWARD FORBES.

" When the shells are examined fully, I will write the results and return them."

Many more might have been given from the same eminent man, bearing testimony to his high admiration of Dr Fleming as a naturalist.

The *Diluvian* controversy first fully revealed to Dr Buckland that he had met his match in the Flisk geologist. For a season they little understood each other. Fleming traced Buckland's "hasty generalizations" to the supposed want of thorough attainments in his favourite science, and Buckland thought Fleming overbearing and self-confident, in questions in geology, to which he believed he had given as much attention as the somewhat hard-headed Scotchman. While they fenced at arms' length, each seemed the foe of the other; but when they closed, as if for a severe struggle for victory, they saw each other in their true character, as sincere students of science, and joined hands in friendship. Buckland's playful notes to Fleming are peculiarly genial:—

" *8th Dec.* 1843.

" My Dear Professor,—Having like yourself been prevented from going to Cork, I send a line to remind you that I am alive, and importing gigantic struthians from New Zealand, more than large enough to have impressed the most colossal ornithichnites. O that I could have been in Ireland to enjoy the triumph of finding *glacial scratches* all over that country, also the counterparts of those in Scotland, Wales, and Cumberland. What is become of your promised paper on these phenomena in Aberdeenshire? and what of the essay on *Peat Bogs*, which no one understands so well as yourself. Pray, pray proceed with both for the good of present and future generations. As a bribe to attack both ice and peat, I send you one of the very few existing copies of De la Beche's Caricature of the astonishment of British monkeys and elephants, at the commencement of the glacial period.

" I remain, yours very sincerely, " WM. BUCKLAND."

" *Oxford*, *12th Nov.* 1845.

" You will, I am sure, be happy to hear that I shall soon be Dean of

Westminster, and most happy to see you there when you come next to London.

"If your Presbyterian Church had not cast off Episcopacy, you might have been, as you deserve, Dean of Glasgow and Aberdeen, but *Diis aliter visum est*. . . . . .

"Yours very sincerely, "Wm. Buckland."

"*Deanery*, 14*th Dec.* 1846.

"My Dear Professor,—I am glad to see by the prospectus you have kindly sent me, and for which I write to thank you by the light of the lamp that was a *fac simile* of yours at Aberdeen, that Hamlet's himself again! and in due time I trust the world will be benefited by your lectures published *in extremis*. I still lecture in Oxford, whither I go in an hour and a quarter, arriving at 11 A.M., and returning to London by 5. The Dean of Ely does the same at Cambridge. Would that you also had been destined to do as much for Edinburgh, but *Delicta majorum*, &c.

"Mrs Buckland unites in best regards, with yours very sincerely,

"Wm. Buckland.

"Have you more than one kind of Salamander in Scotland? Have identified *Labyrinthodon* in New Red Sandstone."

In another note Dr Buckland says :—

"I concluded my letter to the Duke with telling him, in proof of your European reputation, that Professor Agassiz had said to me, 'that he should have been abundantly recompensed for his visit to this country had he gained no more by it than what he saw and learned during the few hours' visit to Dr Fleming.'"

No one of Dr Fleming's scientific friends enjoyed so much of his esteem and love, as the world-famous author of magnificent Siluria. To his admiration of Sir R. I. Murchison as a geologist, he added affectionate regard as a friend. And the tie was mutual :—

"Albeit," wrote Sir Roderick to Dr Fleming in 1844, "the beginning of your letter, I do not think you were 'quite aware' when you wrote to me of the 'manner in which I was employed;' for I was then on my way across the Bothnia Gulph to Abo, threading through a thousand granitic isles. . . . . The Old Red of Russia is proving a very 'piscina mirabile' (Ital.), and I have brought home two large cases of ichthyolitic remains, which, among some species known in Scotland, contain many new forms for Agassiz." Again,—(1846) "I am glad you are able to give such good accounts of Andrew.* I am equally delighted to find that you are 'redivivus,' and serving 'the great cause of science and human knowledge,' as Sir Robert Peel styled it. . . . . This is my birth day (19th Feb.) Time is passing, and I shall not be able to conquer another empire. It is also the eve of our geological anniversary, at which we shall have present for the first time two Deans (Buckland and Conybeare), and a knight grand cross *geological.*" (1856) "Your scheme, like everything you have propounded, is clear and well methodised; but a mere old soldier, who has turned his sword into a hammer, has no right to pronounce upon natural history as a whole! I am only one horse of the team you drive, and I do my best to stick to the collar as long as I can, and it rejoices me to see with what vigour you are really advancing science. . . . . Would that we had a few more men who, like you, can thus systematically and philosophically expound the great principles of natural history!"

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* Dr Fleming's only surviving son, at present civil surgeon at Chupra. Dr A. Fleming has already distinguished himself as a geologist. See "*Report*

The references already made to Sir Charles Lyell will shew the warm regard which Fleming cherished for him, and how highly he esteemed him as a geologist. Though Dr Fleming dissented from many of his generalizations, there was no interruption to a friendship which extended over a period of more than thirty years. The author of "The Principles" was ever ready to forward to his friend in Scotland accounts of what he believed would interest him, and seems to have found in Fleming, what most of the great geologists of his day found—one ever ready to lend all his experience to the solution of difficulties, and ever willing to communicate out of the rich stores of geological knowledge which, by reading and by observation, he had treasured up. Thus letters reached him from Sir Charles, not from London only, but from the Continent and from the United States. Like other friends, Sir Charles was pleased with the continued devotion of Dr Fleming to geology. "I am glad," he writes in 1850, "to see by the abstract you sent me of the proceedings of the Royal Physical Society of Edinburgh, that you are enlightening them both by original observations on the geology of the neighbourhood, and by his-

on the Geological Structure and Mineral Wealth of the Salt Range in the Punjaub, with maps, sections, &c., by Andrew Fleming, M.D., F.R.S.E., Assistant Surgeon, 4th Regt. Punjaub Cavalry. Communicated to the Government of India, 1851–2. See also *Description des Animaux Fossiles du groupe numulitique de L'Inde. Par le Vicome D'Archiac et Jules Haime. Paris,* 1854.

torical retrospect, shewing how much the Edinburgh school has neglected of what lay at their own door."

It appears, however, that his correspondents were not limited to adepts in science. As one put it when information was wanted regarding a rare bird,—"Send it to Fleming. He knows all things living and dead, in air, earth, and water." Lord Cockburn seems to have had like faith in him, when he despatched the following characteristic note :—

"*Bonaly, Colinton*, 3*d Sept.* 1846.

"My Dear Sir,—I send you a creature, which has created much speculation among the rustic philosophers of this parish. It was found yesterday grazing with two friends of the same general appearance, on the leaves of a privet hedge. Some called it the legged worm; some a young locust; but all are agreed that it is the cause of the potato disease. Yours faithfully, "H. COCKBURN."

A like kindly interchange of views on scientific employments, was kept up for several years between Dr Fleming and the able and enthusiastic Irish naturalist, William Thompson, Esq., President of the Natural History and Philosophical Society of Belfast, the author of a peculiarly interesting monograph on the "Birds of Ireland," and of the valuable Report on the "Fauna of Ireland," drawn up at the request of, and published by the British Association in 1840. Fleming's letters to the devoted Irish naturalist, shew how strong his regards were for him, not only as a labourer in the same field with himself, but as a friend :—

"I am glad to find by your note that you have resolved to peruse my brief lucubrations on 'Methods in Natural History'—first, because, very few care about tormenting themselves with the subject—secondly, because, I intend republishing it, or rather something like it, as a small tract, with some additions on analogy, as the substance of some remarks in a controversy with Conybeare in the Ed. Phil. Journ. March 1829, and I should be gratified extremely if on reading, you would *candidly* give me your sentiments. I find the law of continuity, as employed by Liebnitz and Linnæus very imperfectly understood among my acquaintance. To render my
meaning plain, I may state that it is a physical truth that $T \mapsto T'$
anybody which has existed in *Time* at T, and exists at T′ has $S \mapsto S'$
existed through all the intermediate moments. Again, any- $C \mapsto C'$
body which has existed in *space* at S, and exists at S′ has been in all the

intermediate portions of space. Hence Liebnitz was right when in the relations of bodies to *time* and *space*, he said, Natura non operatur per saltum. But what are we to think of those who, finding a *creature* of a particular form at C, and another differently constructed at C′, infer that creatures of all the *intermediate* degrees of form *must* exist; yet this belief led to the law of Linnæus and Bonnet, Natura opifer rerum saltus non facet. A law, this which is the basis of Lamark's 'Progressive Development System,' which led Macleay to dream of Quinarianism, and which seems more or less to influence the views of many modern writers on zoology and botany. I called Strickland's attention to the article in the Quarterly at Glasgow, but I do not think he considered the hint of any value.

"Be assured that any paper of yours will be welcomed by me. I have not the volume containing the report of the Brit. Ass. at Glasgow, and therefore am not at present aware of that portion of its contents to which you refer. I admire the freshness of your zeal, and fondly hope that no withering influence may blight it. I have heart enough to enjoy it in others, while I lament its decay in myself."

"22 *Walker Street, Edinburgh, 29th March* 1849.

"My Dear Sir,—Being within four lectures of the close of my fourth session in Edinburgh, you may well suppose that, what with the condensation required and the illustrations to be produced from boxes, drawers, shelves, &c., I am not in a state to write a long letter, or even to do more than say, your box arrived *before* your letter, and both were welcome in the extreme. Several birds in the box were doubtless not quite in a ball-dress, but even in their ordinary and perhaps worn garb, they constituted a useful addition. The contents of the phial I shall not be able to look at till I get rid of my class on Wednesday. Alas! I indulged the prospect of getting into my new class-room and adjacent apartments in July next, so as to open my next session 1849–50 in an efficient manner. I am now, however, *convinced* that 1850-51 must be the time, and thus, at my time of life, have I been restrained in my usefulness (as I perhaps presumptuously imagine) for four and the prospect of five years. Yet this is but in keeping with my course in life, and if I have been restrained in the field of labour, I would willingly have cultivated, I trust that my higher aspirations as an immortal being have been by the discipline, purified and invigorated. Many thanks for former and present kind services. They may not have been very formally acknowledged, but they have been estimated highly.

"We hear nothing in this quarter about your new colleges. . . . . . . The status of these institutions will necessarily be determined by the character of the first appointments. I earnestly wish they may be judicious. Had such an opening occurred even a dozen of years ago, I would have started, because, I think Ireland a very fine field—*recently* much cultivated, but still with vast stores in zoology and geology not de veloped. Look at what *you* have done, and think of what might be done when even a dozen of good observers shall be sent out every year from Belfast to explore the shores and the glens of Erin. Here you may say look at home, and I feel the truth. In Edinburgh everything is dead.

. . . .

Excuse this scrawl, for I must go to my lectures, can I look for a letter from you when you meet with any thing interesting. Do in charity write, for you exercise a powerful influence in exciting me to exertion. With great regard, I remain, my dear Sir, yours very sincerely,

"JOHN FLEMING.'

In December 1843, Dr Welsh, intimating the intention to start "The North British Review," wrote to Dr Fleming :—"We have resolved to commence a new Journal here, *more under religious control than the Edinburgh and Quarterly Reviews, though not theological.* We are to take assistance from distinguished individuals in England, on the Continent, and in America. Our first number is to appear in April, and I am most anxious that we should have an article from you." Dr Fleming wrote an article for the second number, on "Gould's Birds of Australia." "You have managed the subject in such a way," Welsh told him, "as to make it highly interesting even to an unscientific reader, and I hope your paper will do us much good." Dr Fleming made some suggestions as to the management of the Review, and received in answer :—"Since I last wrote to you, we have met with a severe affliction in the death of a beloved child. He had been seized with scarlet fever a few days before, but it was in a mild form, and no danger was apprehended. On Friday morning, however, he was worse, and in twenty-four hours, after many alternations of hopes and fears, it pleased the Almighty to take him to himself. Your letter has recalled me to the business of the world. . . . . Your suggestion about a sheet for critical and miscellaneous notices is well worthy of consideration."

Dr Fleming continued to write at intervals for the "North British" till the time of his death. His papers are all of value, as not being limited to a *resumé* of the subjects treated of in the works reviewed, but as containing much matter drawn from his own observations in science. The second article contributed was one on "Dana's Mineralogy" (1845). In the introduction to this Paper, he illustrates fully those views of the weakness of "Paley's Argument," to which reference is made in his letter to Dr Chalmers (p. lxxxv).

In this outline of Dr Fleming's life, I have not named nearly all his contributions to science, but have been guided in my choice by what seemed to me illustrative of his special attainments. The only other contributions which may be mentioned here are his Address to the Royal Physical Society on "*National Museums*," his small volume on "*The Temperature of the Seasons*," his Address "*On the Branches of Knowledge included in the term* NATURAL HISTORY," and the "*Lithology of Edinburgh*."

The first of these (1849) was published, along with an able article on the Address from the *Witness*, by Mr Hugh Miller, and obtained a large circulation. Five hundred copies of the Address, with the remarks of the Editor of the *Witness*, were circulated by the Society. This address has already borne good fruit. "The Temperature of the Seasons" is not so generally known as it ought to be. I am not aware of the existence of any volume in the popular literature of science, on the same subject, so admirably fitted to convey information to non-scientific readers, on matters that pass under their notice every day, and to beguile the young to the study of phenomena of great interest, and which are sure to give a taste for observing nature. The "Review of Natural History Studies" formed the subject of an address, delivered at the Glasgow Meeting of the British Association (1855) by Dr Fleming, as President of Section D (Zoology and Botany, including Physiology). Some of the passages in this address remind us of the controversies with Buckland and with Conybeare. "Why," he asks, "is geology so popular? In answer, we simply refer to a well-known fact, that the great majority of readers and hearers of scientific subjects, treated in a popular way, are delighted to wade in waters beyond their depth; and this occasions no alarm, because they have always sufficient floating power to rise to the surface."

The "Lithology of Edinburgh" was on the eve of publication at the period of Dr. Fleming's removal. He had superintended the whole of it through the press, with the exception of the last half-sheet. It is now published along with his Memoir, without note or alteration. I believe it to be the ablest treatise we have on the subject. It no doubt contains views directly at issue with those held by highly distinguished labourers in the same field. Since the sheets of the "Lithology" were put into my hands, a short time after the death of Dr Fleming, I have gone over the ground described; and, though intimately acquainted with it when a student, and familiar with Mr Maclaren's able and valuable work, I have had very frequent occasion to admire the correctness of observation, shrewdness of hypothesis, and breadth of view brought to bear, in "The Lithology,"* on peculiarly interesting phenomena, set by him in lights entirely new.

Dr Fleming died, after a short illness, on the 18th of November 1857. When the word, "come up hither" reached him, he was not unready. Devotion to science had not interfered with love to the Saviour. Under the ministry of the Rev. James Lewis, a pastor whom Dr Fleming much esteemed and loved, he had been ripening for those everlasting and incorruptible habitations, where intellect, not less than affection, shall attain the highest enjoyment. He had not lived in vain. The scientific literature of his own and of other lands will ever bear witness to his success as a student and a discoverer. He had read God's thoughts in nature wisely, and had studied His thoughts in the infallible Word, as a sinner deeply conscious of sin and guilt, needing a Saviour, and having found one in "the man Christ Jesus"—the eternal God. And there is good reason to believe that he had not been without tokens in his ministry that God, who had revealed Christ in his own soul, had blessed his labours to others. While, too, he realised his true position as a Christian apologist in connection with modern phases of scientific speculation, others, who walked with him in the paths of pure science, were not slow to acknowledge his work in *this* respect. The expression of regret for his loss, entered on the Minutes of the Royal Physical Society concludes thus:—"In his capacity as Professor of Natural Science in the New College, it is believed that Dr Fleming has been eminently successful in imparting much of his own healthy spirit to the many students who have listened to his prelections, while his own full testimony to the compatibility of a sincere belief in revealed truth with the acceptance of the facts and views of modern science, must have helped not a little to stem the torrent of speculative infidelity which threatened not long ago to break forth in our land."

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* It may be remarked that the *mammoth tooth*, referred to at p. 64, of the Lithology, is in the possession of John Maitland, Esq. The following note, kindly communicated to me by Mr Maitland, led me to look at the district in which it was found; and I am persuaded that Fleming's doubts as to its connection with the "Boulder Clay" are well founded:—

"*Measurement of Mammoth's Tusk, made by J. Maitland, 26th Nov.* 1858.—Extreme length by the outer curve, exactly 39 inches; circumference at the middle, 13 inches; ditto at *small* end, 11⅜ inches; ditto, thick end, 12⅝ inches. The tusk is in four parts,—the main centre piece, 24¾ inches long, and three fragments as cut up by Wauchop, the ivory-turner on the South Bridge, Edinburgh, who bought it from the man who found it. That this is the same tusk that was described by Mr Bald, as found at Clifton Hall in July 1820, in digging the Union Canal, I am quite certain. I recollect the finding of it perfectly, though I did not *see* it until its return from Edinburgh. I recollect of Mr Bald getting it away when he was to notice it at the Wernerian Society; and I recollect when he returned it; and I have lived in the same house with it ever since. But Mr Bald is wrong in stating it was found in the *West* Park of Clifton Hall; it was found under the surface in the *Dove-cot* part, but *close to* the *West Park*, which the canal only touched."

LITHOLOGY OF EDINBURGH.

CHAPTER I.

History of Edinburgh Lithology—Bulmer and Atkinson—Sibbald—Sinclair —Hutton—Playfair—Hall—Allan—Greenock—Walker—Thomson—Williams—Townson—Jameson—Hibbert—Patterson—W. Nicol—Rhind —Milne—Maclaren—Museum and Scientific Societies.

The neighbourhood of Edinburgh presents a very remarkable assemblage of different *rocks*, and several interesting *mineral species*, important to the student of theoretical and practical geology ; yet it was not until the close of the last century that their characters began to be studied, or the resources of science called upon to furnish the requisite illustrations. Previous to this period, our Scottish observers were principally occupied in "mine-hunting," and under the auspices of Sir Bevis Bulmer, Stephen Atkinson, and other "menerall men" of that ilk, every rock, ravine, and river were explored in search of gold and silver, and reported, in many instances, as being found in places where, in later times, they have been sought for in vain. Thus, in the preface to the translation of a French account of the life of James V., printed in a volume entitled, "Miscellanea Scotica" (London, 1710), it is said "the Laird of Marchestone got gold in the Pentland Hills." The reader who wishes further information respecting the treasures disclosed during this active metallurgic era, will find considerable entertainment by the perusal of "*The Discoverie and Historie of the Gold Mines of Scotland, by Stephen Atkinson, written in the year* 1619." An edition of this curious work, with additions, was published by the Bannatyne Club in 1825. Notices of the discoveries of this period may likewise be found in the various topographies of Sir Robert Sibbald. In his "Scotia Illustrata," and in connection with this district, he merely notices, under the head of Bitumens, "*Oleum Fontis S. Catharinæ.*" But in the work quoted above (p. 84), Sibbald has stated, on the authority of Colonel Borthwick :—"There was lately found within four miles of Edinburgh, copper upon Curry water, in John Scot of Lamphoy's ground. I have seen good copper got out of it." "The Colonel shewed me a piece of lead found within four miles of Edinburgh. The Lapis Hæmatites is also found in Scotland, particularly in the King's Park, at Edinburgh." "At Braid Craigs there is a stone with many blue and green veins, that argues there is copper in it."

The attempt to unfold some of the first principles of geology was begun in Scotland by George Sinclair, Professor of Philosophy in Glasgow; but the results which he published in the "Miscellany" accompanying his treatise on "The Hydrostaticks" (Edinburgh, 1672), have met with unmerited neglect. Professor Sinclair is known, indeed, to a few inquirers, as the first individual in Scotland who repeated the experiment of Pascal on the different heights of the mercury in the barometer at the bottom and top of mountains, selecting Arthur Seat as the field of his operations, and to many as the reputed author of "Satan's Invisible World;" but we have not found an acknowledgment of his illustrations of the structural character of the coal-measures, unless we consider as such a couple of condemnatory remarks by Mr Milne, in his memoir on the coalfields of the district, to which we shall shortly make reference. In his preface to the "Hydrostaticks," Sinclair says that there "is added a short *history of coal*, which I hope will be acceptable to some; this, so needful a subject, never being treated of before by any. In it mention is made of things common to *coal* in general, as *dipps, risings*, and *streeks*.

Next, of *gaes* or *dykes*, which prove so troublesome to the working of *coal*. Thirdly, of *damps* and *wild-fire*. Next, a method is taught for trying of grounds where never any coal was discovered before. And lastly, the manner how *levels* or *conduits* under ground ought to be carried on for draining the *coal* and freeing it of water." In the course of these illustrations, he satisfactorily establishes the existence of *chokedamp* (carbonic acid) in a coal-pit at Tranent, and of *firedamp* (dicarburet of hydrogen) at Werdy, "be-west Leith."

In the spring of 1785, the celebrated Dr John Hutton laid before the Royal Society of Edinburgh his leading views of a "Theory of the Earth," which afterwards appeared in 1788, in the first volume of the Transactions of that body, and afterwards in a separate and more extended form, in two volumes octavo, in 1795. The speculations, which Dr Hutton thus presented to public notice, did not fail to excite a deep interest in the minds of those who were occupied with the study of geology, because many recondite subjects were brought prominently forward, and fearlessly discussed, while appeals were as boldly made from the closet to the quarry—from the hall of the Royal Society to Salisbury Craigs and Arthur's Seat.

Dr Hutton, without perhaps any very intimate acquaintance with minerals as species, or with rocks as constituted by their aggregation, had become fully convinced that great changes in the constitution and position of the strata had taken place, and he assigned to himself the task of *explanation*. There are few observers who would venture to express a doubt that sandstone, slate, and coal, were originally sand, mud, and peat. He endeavoured to determine the agent which had so greatly changed their characters, and produced the metamorphic condition; and this agent he announced to have been *heat*. It is equally obvious that these strata, which were originally assorted by water under the influence of gravity, have been broken and variously displaced from their first horizontal position. He likewise undertook the task of determining the character of the disturbing agent, which he believed to have been analogous to the cause of earthquakes and volcanoes.

Although Dr Hutton failed, in many instances, to reach the truth, by neglecting to make accurate observations, by the employment of imperfect premises, and by overlooking residual or unexplained phenomena, he, nevertheless, drew around him several kindred spirits, who screened him from charges not easily evaded, protected him from misrepresentations to which the obscurity of his style peculiarly exposed him, and expounded his views by the aid of descriptive geology of a local character. The most eminent and successful of Dr Hutton's supporters was the amiable and accomplished Playfair, who gave, in the "Illustrations of the Huttonian Theory of the Earth" (Edinburgh, 1802), a luminous exposition of the geological tenets of his friend, and thereby contributed, in a very great degree, to render these intelligible and popular. But the illustrator of Huttonianism laboured under the same defects as its founder. He had never studied mineralogy, so that his knowledge of rocks was necessarily imperfect; nor had he ever applied himself to the task of marking their more ordinary gradations of character, their interjacencies, and their contents. He appeared, therefore, as a *special pleader*, anxious to conceal the weaker points of the case of his client, to overrate the statements which were tenable, and ever seeking to turn the attention of the reader, where practicable, to the inaccuracies of his antagonist.

Sir James Hall likewise strengthened the speculations of Hutton, in no ordinary degree, by a series of well-devised experiments, rendering probable some of the hypothetical explanations of his school, and at the same time extending our knowledge of the character of mineral masses. The first of these essays was entitled, "Experiments on Whinstone and Lava," published in the Transactions of the Royal Society of Edinburgh, vol. v. p. 44. The specimens were chiefly selected from rocks in the immediate vicinity of Edinburgh, and the results had their value greatly increased by the co-operation of Dr Kennedy, who published in the same volume "a chemical analysis of three species of whinstone, and two of lava," p. 76. The "whin of Salisbury Rocks," and the "whin of the Calton Hill," form two of the species employed. The effect of heat on these rocks was here illustrated in a very judicious manner. The second paper gave an account of a series of experiments, shewing the effect of "compression in modifying the action of heat," which was published in the Edin. Trans., vol. vi. p. 71. His third contribution, and one of no ordinary value, to which we shall have occasion to refer, is styled "On the Revolutions of the Earth's surface," Edin. Trans., vol. vii. p. 139.

The late Mr Thomas Allan's communication to the Royal Society of Edinburgh in 1811, "On the Rocks in the vicinity of Edinburgh," is in several respects of great value. Intimately acquainted with mineral species, and with rocks, he has furnished the most important contributions to our knowledge of Edinburgh lithology of any member of the partisans of either Hutton or Werner.

The last production of the Huttonian school to which reference need here be made is that of Lord Greenock (now Earl Cathcart) to the Royal Society, 1833, having for its title "A general View of the Phenomena displayed in the neighbourhood of Edinburgh by the Igneous Rocks, in their relations with the Secondary Strata; with reference to a more particular description of the Section which has been exposed to view on the south side of the Castle Hill." This paper is chiefly occupied with hypothetical views respecting "the apparent interstratification of the trap and secondary rocks." In another communication to the same Society, his Lordship offers "General Remarks on the Coal Formation of the Great Valley of the Scottish Lowlands," and has made reference to the rocks of the neighbourhood.

The school of geology which Hutton had thus succeeded in establishing may be said to have flourished during the twenty years which succeeded the first exposition of his views in 1785. But during this period, however, there were three individuals who exercised a considerable influence on our local geology, irrespective of the speculations referred to. Among these, Dr Walker, who honourably occupied the chair of Natural History in the University, deserves the earliest notice. The lectures which he delivered to the students on that branch of his course in which he treated of geology, must have been highly interesting, if we may judge from the various entries, which appear in his "Institutes" (Edin. 1792). Besides, he directed the attention of his pupils to the condition of rocks, and afforded them important assistance in the use of discriminating characters, evidently employing as his guide the judicious labours of Wallerius. This is well exemplified in his "Classes Fossilium," (Edin. 1787), a small treatise on minerals and rocks, indicating an advanced state of information on the subject; and in a fragment of "Description of Strata," given in Headrick's Arran, p. 237. No one can peruse the brief autobiography of this intelligent man, in the *Edinburgh Philosophical Journal* for January 1822 (vol. vi. p. 83), and bear in mind the hard fate of his wasted collection and scattered manuscripts, without a deep-felt conviction that justice has not been rendered to his memory.

Thirty-five years ago I published the following remarks in connection with Scottish Botany (*New Edinburgh Review*, Oct. 1821), which seem equally called for at the present time. "It is impossible to mention the name of Dr Walker without bewailing the loss which his botanical fame has sustained. It is well known that he had explored the vegetable productions of Scotland, not merely with an industrious, but a philosophical eye, and that he was more intimately acquainted with the extent of our Flora than any dead or living botanist. But he neglected, during his lifetime, to publish his numerous observations, and the works now quoted include all which have appeared since his death. Many of his manuscripts are in a finished state, and ought to be given to the public. His herbarium, instead of being scattered about among different collectors, and parcels of his rarest specimens sold along with their herbaria, should be deposited in the museum of the college, where, it is to be hoped, it would share a better fate than the one which Sir Andrew Balfour bequeathed.* It is not long since Walker's collection of minerals, including many specimens illustrative of the geographical mineralogy of Scotland, were lying in one of the low damp rooms of the college, (perhaps they still remain,) covered with dirt and grease. His zoological collection, exposed to similar treatment, has been in a great measure annihilated by the combined influence of the mites and moths. Such, indeed, is the respect which we entertain (and it is not cherished inconsiderately) for the memory of this great but neglected naturalist, that we are persuaded, that had he, in his vigorous days, published a Flora Scotica, it would have been the best work of the kind in Europe, and would have placed its author among the first botanists of the eighteenth century."

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* Dr Walker, in his Memoirs of Sir Andrew Balfour, states that "the whole plants preserved in his travels, bound in several volumes, were in his

These remarks produced some effect, for we find Professor Jameson, shortly thereafter, furnishing, from Dr Walker's manuscripts, in his possession as one of his trustees, the autobiography to which we have referred. At its close, the following remarkable passage and note occur :—"The catalogue of my collection contains 1569 species and varieties of minerals, arranged under the above genera ; but of these there are so many duplicates and varieties of less note, that the number of specimens may probably amount to above 3138. These, however, do not form the whole of my collection. They are extracted from the general register of my museum, which contains many minerals, that, for want of examination, could not

Museum after it was placed in the College of Edinburgh. But the collection, which would now be of great value, has since disappeared.—Essays, p. 355. Afterwards he says, "His Museum was deposited in the College of Edinburgh, in the hall which is now the library; and there is reason to think it was then the most considerable that was in the possession of any University in Europe. There it remained for many years useless and neglected; some parts of it going to inevitable decay, and others abstracted, yet even after the year 1750 it still continued a considerable collection, which I have good reason to remember, as it was the sight of it about that time that first inspired me with an attachment to Natural History. Soon after that period it was dislodged from the hall where it had been long kept; was thrown aside; and exposed as lumber: was further and further dilapidated, and at length almost completely demolished."—Ib. 365. To this collection Sir Robert Sibbald added the fruits of his own industry and published a catalogue,—"Auctarium Musæi Balfouriani e Musæo Sibbaldiano." Edin. 1697.

be inserted in their proper places in the catalogue." In the note appended, it is stated,—"The collection, we understand, will soon be arranged for public sale by the trustees of Dr Walker."

The collection, which we saw at the time referred to, has never been arranged and brought to public sale, but has disappeared in some mysterious manner, no one in the college being able to tell when it was removed, or where it has been placed!!

While the lovers of science belonging to Edinburgh have cause to bewail the wasted collections of Sir Andrew Balfour and Dr Walker, they have not less cause of sorrow at the fate of the collections and the funds of the late Dr Thomson, who by will, dated Palermo, 14th May 1800, destined them to be applied *for the promotion of Mineralogy as a branch of natural knowledge in the University of Edinburgh.* The management of the property was vested in the Lord Provost and Magistrates, and, in 1821, they realised to the extent of £1511 : 4 : 2, together with a valuable collection of minerals, with cabinets for their preservation. In consequence of the bankruptcy of the city the interest or annual may now be regarded as only equal to £45. Four-fifths of this sum were to be employed as salary to the LECTURER, and one-fifth in preserving and increasing the COLLECTION. The annual became available after the death of an annuitant in February 1848.

So early as 1808 the Professor of Natural History received the appointment to this office, and thus swallowed up the Lectureship, removed the possibility of rivalship, and secured the use of the collection for the illustration of his lectures, which at this period were almost exclusively occupied with Mineralogy and Geology. The Council at this time commenced fitting up the old Humanity Class Room for the reception of the collection, and by the 4th Aug. 1813, "Bailie Johnston reported that the valuable collection of minerals had been arranged in the museum."

To this hour no separate LECTURER on Mineralogy has been appointed; the funds have gone into the pockets of the occupants of the chair of Natural History, and, assuming that the class has been conducted according to the "Institutes" of Walker, and as afterwards by Jameson, mineralogy in Edinburgh has derived no benefit from the bequest. The collection, declared by the donor to be "valuable and inestimable," admitted by Professor Jameson to have "materially enriched the museum," and who became bound on his receiving the Lectureship "to preserve in good order the whole collection of minerals;" this collection has been spoiled; its most valuable specimens mixed up with the public collection, and handed over to Government by the Magistrates, its guardians; and its wreck of unnamed materials stowed away in three boxes, labelled "Thomsonian Collection," and deposited in a room under the Library; while the cabinets have been lost or appropriated to other purposes. The Magistrates became bound to visit the collection annually, but no visitation ever took place. The fifth of the annual has never been applied in preserving and increasing the collection, but, under the countenance of the Council, went for six years along with the other four-fifths into the pockets of the *quasi lecturers*. Thus the funds have been misapplied, and the beneficent intentions of Dr Thomson systematically evaded.*

The second author who enlarged the bounds of our local geology, was Williams, who published in two volumes octavo (Edin. 1789), "The Natural History of the Mineral Kingdom." His detailed account of the coal-measures of the neighbourhood, their contents, and derangements, greatly advanced the study of practical geology, not only in Edinburgh, but throughout Scotland. Mr Milne, in his "Memoir on the Mid-Lothian and East-Lothian coal fields," presented to the Royal Society in 1838, and published in the 14th vol. of their Transactions, p. 253, and in the following year produced in a separate form with additions, has passed a very severe censure on the labours of Williams. He says, " Williams, in his '*Mineral Kingdom*' (published in 1810), gives some information regarding the direction of the Gilmerton and Loanhead coal-seams. But the information contained in both these works " (Sinclair had been referred to), " even respecting the coal strata, which alone they professed to treat of, is extremely vague, and generally very erroneous." This is the first time that such a sweeping condemnation of the descriptions of Williams has been uttered, and to be satisfied of the groundlessness of the charge, the facts stated by Williams and his judge require only to be compared. It seems probable that Mr Milne tried Williams by the geological standard of 1810, the year he assigns to the publication of the work, instead of 1789, the year in which it actually appeared. Mr Milne does not seem to have been aware that the work of 1810 was a *second edition, with additions by James Miller, M.D.*

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* "Report by the College Committee to the Town Council of Edinburgh regarding Dr Thomson's bequest for the promotion of Mineralogy in the University of Edinburgh, 12th February 1856."

The third author who, during this period, illustrated the character of the strata around Edinburgh, was Townson. In his " Tracts and Observations in Natural History and Physiology " (London, 1799), he dedicated a portion of the work to " Remarks on the Mineralogy of the Environs of Edinburgh," in which he illustrated the character of the Calton Hill, Salisbury Craigs, and Arthur's Seat, in a manner highly creditable to his discernment as an observer. His view of the structure of Arthur's Seat, in particular, is in accordance with the most recent determinations of its arrangements; and yet, passing strange, the statements of this author have not been noticed, or in any degree referred to, by any of those authors we have mentioned, or are yet to notice, who have occupied themselves with our local geology.

Being much surprised by the fact, that none of the local observers, to whom I had access, seemed to be aware of the existence of such a work, I communicated to the Royal Society of Edinburgh, 20th April 1840, the most interesting passage: —" The first of the chains or ranges of rocks that I lately described as lying at the back of Salisbury Crags extends from Arthur's Seat to St Anthony's Chapel. It is composed of basalt and sandstone, neither of which are like the whin and sandstone of Salisbury Crags. The basalt is the same as that near to Duddingstone Loch. The stratafied matter forms a bed two or three yards thick near St Anthony's Chapel. Some of it is very hard, and strikes fire with steel, but effervesces with acids, and has an argillaceous smell; but the greatest part is soft and friable, and seems to be merely the finer debris and powder of the breccia, perhaps a kind of trass or terrass. *It contains a great many vegetable impressions, with the charred matter still existing.* They appear to be the same which are so frequently found in the strata that accompany coal. The large irregular basaltic columns at St Anthony's Chapel rest upon this." (*Proceedings*, p. 214.)

This remarkable silence in reference to the labours of Townson is the more inexplicable, when we find in a biography of Jameson by his nephew, that he was not only aware of the views of Townson, but read a paper before the Natural History Society of Edinburgh, having this title, "An examination of Mr Townson's Description of Arthur's Seat."—See *Edinburgh New Philosophical Journal*, No. 113, July 1854, p. 9.

We now enter upon the consideration of another interesting era in the history of the geology of Edinburgh, in which the doctrines of the school of Werner were destined to exercise a powerful influence. The appointment of Professor Jameson, the favourite pupil of Dr Walker, to be his successor in the chair, in 1804, raised high expectations, and they were speedily realised. The notions of the Huttonians at this period respecting the laws of superposition of the strata were very defective, scarcely amounting to perceivable glimmerings. But Professor Jameson, intimately acquainted with the geognosy of Werner, speedily began to group the rocks of the neighbourhood into their distinct formations, and to assign the relative position of our Transition Rocks, Old Red Sandstone, and the Independent Coal Formation. This important step, in the progress of our geology, was followed by a system of prelections, accompanied by excursions to the more important localities where the phenomena could be studied in the field, and produced a number of zealous observers, who have not only extended the knowledge of the structure and contents of this locality, but of the United Kingdom and its dependencies.

The published contributions to the geology of Edinburgh furnished by Professor Jameson directly, it is to be regretted, are few in number, but they are of great value. Among these may be mentioned—1. "On Secondary Greenstone and Wacke." *Edin. Phil. Journal*, June 1819, vol. i. p. 138. In this paper the trap rocks of Lothian Street, Calton, Salisbury Craigs, and Burntisland, are illustrated.—3. "Geognostical Description of the Neighbourhood of Edinburgh." Ditto, p. 252.—3. "Outline of the Mineralogy of the Pentland Hills." *Wern. Mem.*, xi. p. 178. Other incidental notices in connection with the district occur in various other communications of the Professor, to which we shall have occasion to refer.

The pupils of Professor Jameson have, to a considerable extent, supplied the reserve of their master, and furnished many important communications illustrative of the geology of Edinburgh, to a few of which we shall now briefly advert. It may be requisite, however, to state that, when it is known that these individuals not only enjoyed the privilege of attending the lectures and excursions of their preceptor, but had ready access to him for the removal of their doubts, there is very great difficulty in determining the amount of merit due to each, and separating the opinions and speculations of the pupil from those of the teacher.

The first communication of this sort, which claims precedence in time, is by Dr Hibbert, "On the Freshwater Limestone of Burdiehouse, in the Neighbourhood of Edinburgh, belonging to the Carboniferous group of Rocks."—*Edin. Trans.*, vol. xiii. p. 169. Although the subject of organic remains was evidently in a great measure new to the author, yet we owe to his zeal, on this occasion, a valuable addition to the palæontology of this district. The fossil fishes and plants of that very interesting deposit, the "Burdiehouse Limestone," were figured and described, perhaps not very scientifically, while the relations of the marine and fresh-water limestone to the contiguous coal-measures were, for the first time, attempted to be established. The credit of the paper, however, we must add, is injured by insinuations of ill-treatment from others, apologies for his own blunders respecting his Saurian prejudices, and by a dogmatising style altogether unsuitable to one who was feeling his way through comparatively unknown materials. Still, Dr Hibbert did excite a certain amount of zeal for the study of organic remains, unfortunately not encouraged in other quarters, and which the late Secretary of the Royal Society, Sir John Robison, effectively strengthened. With these convictions, we willingly adduce the testimony to the same effect given by Lindley and Hutton in their "Fossil Flora." "To the Royal Society of Edinburgh also, as a body, the scientific world are deeply indebted, they having promptly stepped forward, at the suggestion of Dr Hibbert, and with a power which could be commanded by no individual, rescued the fossils from destruction and dispersion, preserving to themselves one entire set, which they most liberally lay open to all those who feel an interest in them."—Vol. iii. p. 27.

The next communication to which we shall refer is of small compass, containing, however, valuable materials—viz., "On the Fossil Organic Remains found in the Coal Formation at Wardie, near Newhaven," from the pen of Dr Patterson of Leith, and inserted in the *Edinburgh New Philosophical Journal*, for July 1837. This observer, though opposed to Dr Hibbert in reference to the marine or lacustrine origin of the limestones, &c., of the neighbourhood, being far more intimately acquainted with fossil plants and fossil fishes, has communicated a list of species, with remarks illustrative of their character, which cannot fail to aid the studies of the young palæontologist.

Here, and in connection with organic remains, would we briefly refer to the discoveries and labours of an individual who contributed towards the elucidation of the intimate structure of recent and fossil organisms, to an extent of which few seem to be aware, and to which fewer still have the honesty to do justice. To the late William Nicol, Esq., Inverleith, Edinburgh, the students of fossil organisms are indebted for the processes by which thin slices of petrifactions can be prepared, so as to permit the application of the microscope to the examination of their intimate structure. It is to the processes and the manipulations of this observer that we are indebted for our knowledge of the relation of the fossil trees of Craigleith and Granton Quarries, to the firs, or rather to the Araucarias, of the present day. Indeed, without borrowing from the resources of Mr Nicol, the work of Witham on fossil vegetables would have possessed little interest—the "Fossil Flora" would have been greatly limited, while the "Odontography" might not have had a being. Justice may for a time be withheld, the mantle of a John Hunter may be worn as the property of a Sir Everard Home, and other names may be in the place which Nicol's should occupy, but ere long the truth will prevail, and the merit of original discovery and observation be recognised. It may be added, that the valuable collection which Nicol formed was bequeathed to his friend Mr Alexander Bryson, who is not only capable of appreciating its value, but who, possessed of equal power of manipulation, is rapidly adding to its treasures.

In 1846 Mr Rhind published his little volume, under the title "Excursions illustrative of the Geology and Natural History of the Environs of Edinburgh." The object and plan of this work are alike commendable, but the resources of the author, at the time, were not equal to the task.

The communication of Mr Milne, now Mr Milne Home, "On the Mid-Lothian and East-Lothian Coal Field," to which reference has been already made, abounds with much important information, collected with great industry from twenty-two of the coal proprietors and managers of the districts, respecting the structure and dislocations of the coal-measures. The author has likewise treated of the "Superficial Strata" in the neighbourhood of Edinburgh, with a fulness of detail which gives very great additional interest to his memoir.

Another communication to be noticed is that of Cunningham "On the Geology of the Lothians," to which the Wernerian Society adjudged a premium of twenty sovereigns. This

Essay contains many interesting descriptions of the relations of the strata, but is singularly defective in its references to organic remains. Yet the author somewhat unguardedly observes —"If geologists have in the course of their investigations come to any certainty concerning the ancient state of our globe, there is certainly no one doctrine supported by a greater number of facts than that of *progressive development!!*"—*Wern. Mem.*, vii. 3.

The last of the treatises illustrative of the geology of Edinburgh, which we shall notice, is Mr Maclaren's important "Sketch of the Geology of Fife and the Lothians," Edin. 1839. It abounds with detailed descriptions of the rocks of the neighbourhood, accompanied by sections and diagrams of the more interesting phenomena, and has aided, to a very great extent, the researches of the private student. In too many instances, however, the author has indulged in hypothetical explanations, and has, in a great measure, overlooked the organic contents of the strata. The work has been for some time out of print, and a new edition, believed to be in the press, has been long and anxiously looked for.

In addition to these communications, we may mention that several references to the lithology of Edinburgh occur in the writings of Faujas Saint Fond, Webster, Boué, L. A. Necker De Saussure, J. Nicol, and others. To the observations of these authors we shall endeavour to do justice, as opportunity offers.

From the preceding remarks, the reader may be disposed to conclude that our knowledge of the lithology of the neighbourhood of Edinburgh is extensive, that the subject has been handled by many intelligent observers, and that very little remains to be done, except perhaps to collect and arrange, in a more convenient form, the observations which have been already secured. This, however, would be a very inconsiderate conclusion, for the very same remarks which fell from the pen of Mr Allan thirty-five years ago, are at the present moment as applicable as ever. "It may be thought that the subject is exhausted. But this is an error I am very desirous to combat, not only because, in my own experience, I have found it to be one, but because, as science advances, our habits of investigation improve, phenomena become more familiar, we learn to trace and to secure not only the objects we are in pursuit of, but also to detect others which our less practised eye had originally passed over unnoticed." "We all think ourselves perfectly acquainted with the rock on which our Castle stands. But I suspect there are many members of this Society who will be surprised to learn that sandstone occurs near its summit and also at its base. Salisbury Craig and Arthur Seat appear perfectly familiar to us; there are phenomena belonging to both, however, of which, I have no doubt, many are yet ignorant."—Edin. Trans., vol. vi.

Considering the length of time during which mineralogy, petralogy, and palæontology have been taught in the class of Natural History, the state of our public collection is far from satisfactory. Until a very recent period, the MUSEUM did not furnish the student with adequate resources, but exhibited, rather, attractive specimens from *distant* localities. The late lamented Professor E. Forbes, during his brief occupancy of the Chair of Natural History, began to collect and exhibit specimens illustrative of the petralogy of the neighbourhood, and the organic remains in our rocks, especially those belonging to the animal kingdom, would speedily have occupied his attention. There is good ground to hope that his successor in office will follow out those views which he so unequivocally expressed and laboured so enthusiastically to accomplish. The vegetable organisms of the strata around Edinburgh are beginning to attract some share of attention, and the collection which Dr Balfour has already formed in the Museum of the Botanical Garden is calculated to aid the researches of the young palæontologist.

The SCIENTIFIC SOCIETIES of Edinburgh have to a considerable extent contributed to the progress of Edinburgh Lithology. The Royal Society has always given a certain amount of encouragement to local inquirers. The Wernerian Natural History Society, now extinct, was for several years in active operation. The Transactions of these two Societies have already been referred to, and several of the papers which they contain are of great interest. The Royal Physical Society now occupies the field which the Wernerian Society was wont to cultivate, and has given indications of a useful career.

There is yet another institution to which the lovers of Lithology in Edinburgh may reasonably look forward, as destined to advance the interests of their favourite science—the INDUSTRIAL MUSEUM. It is a matter of deep regret that, for the present, the funds necessary for its progress and usefulness have been ungraciously withheld. But the common sense of the public will, ere long, recognise the value of such a collection as calculated to advance the interests of society. Meanwhile, we trust that the GEOLOGICAL SURVEY will be preparing to furnish its invaluable contributions. Its staff of efficient *observers,* and equally active *collectors,* may be looked to for speedily furnishing more trustworthy results, respecting the distribution and contents of the rocks, than can be expected from private and uncombined exertion.

CHAPTER II.

Origin of the picturesque scenery around Edinburgh—Valleys, Ridges, Bays, and Nesses—Valleys of abrasion and their bifurcation—Rivers, Reaches, Craig, and Tail.

THE remarkable irregularity of the ground in the neighbourhood of the city, and the equally varied aspect of the sky-line in every direction, have long attracted the notice of the lovers of landscape, and usually excite in the breast of strangers a feeling of intense admiration. But the eye, which has enjoyed a geological training, is enabled, besides being gratified by the same picturesque scenery, to detect groups of interesting phenomena well fitted to excite reflections of a more intellectual kind. The abrupt faces of the rocks, the inclination of the beds and their fractured contents, indicate a violent disruptive force acting from below, while a different agency has spent its fury on the surface, removing or assorting the softer materials, leaving the harder portions, the protuberances, ridges, or hills, as an index of the devastation which has occurred.

Before, however, entering upon the details of the surface inequalities of the district, I shall take liberty to remark, that much difference of opinion prevails respecting the character of the forces which have been in action, their origin, and the direction in which they have exerted their influence. Hence it is expedient, where practicable, to attend to some of the more obvious but too much neglected elementary truths, that aid in observing the phenomena satisfactorily, and test the explanations which have been offered.

When we examine a VALLEY of any extent with the eye of a petralogist, it will be found generally that the rocks existing in the trough, are softer and more easily acted upon by air and water than those which form the bounding ridges. Interspersed portions of harder rock may be occasionally found among the softer materials, but these will merely cause inequalities in the valley, and mark, by their elevation, the resistance which has been offered to the disintegrating forces which have reduced the contiguous portions to a lower level. The valley of St Leonards, the North Loch, and that of the Hunter's Bog, may here be quoted as illustrative examples.

When we examine a BAY, or indentation on the coast, we generally find analogous appearances. The softer beds have been acted upon, broken up and removed by the action of the *ripple* of wind or storm waves, while the harder materials remain and constitute those promontories or NESSES, which form the lateral limits of the recess or creek. Even in the bay, as in the valley usually connected with it, certain portions of harder rock may have existed, and such will usually be preserved as *islets* or skerries, to mark the abrasion which has taken place around.

The young petralogist may witness very distinct evidence of this view of the formation of bays at Granton or Trinity. At either of these places the beds of *sandstone* resist the abrading agency of the sea ripple far more successfully than the softer beds of argillite or *shale* with which they are interstratified. Hence all the hollows on the beach, or indentations at the sea margin, can be successfully referred to their forming agent, acting readily on the shale, but withstood more or less by the sandstone. Indeed, the promontory of Joppa, the ridge of the Black Rocks at Leith, and the projecting portions of the shore at Granton, may be studied with advantage as illustrative examples. The islands of the Firth of Forth give likewise unequivocal indications of the resistance offered by the harder rocks, which, in general, in this quarter, belong to the trap family. Thus the Bass, May, Inchkeith, Inchcolm, Inchgarvy, and others of minor bulk, plainly indicate the extent of abrasion which has taken place, and the means of their preservation. Irrespective of the groups of rocks in the immediate neighbourhood, which we shall soon consider in detail, the spectator, looking around from the Castle, the Calton, or Arthur's Seat, will perceive numerous hills rising somewhat abruptly above the surrounding land, and all of them illustrating the truth we are now endeavouring to enforce. Thus, on the south, we have Blackford, Braid, and the Pentlands. On the west, Dalmahoy, Binney, and Corstorphine. On the north, the Binn, the more distant Lomonds, and Largo Law ; while, on the east, North Berwick Law is perhaps the most striking example in the horizon, exhibiting its conical mass of trap, while the softer sandstone which had surrounded it has disappeared.

In examining the physiognomy of a district, on the great scale, these remains of abraded strata, in the form of hills or hummocks of trap-rocks, are of great value, equally to the lover of truth and the hypothetical visionary. When examining a district petralogically and in detail, the knowledge of the unequal powers of resistance of hard and soft rocks to ordinary atmospheric and weathering influences, and the more violent operations of abrading agents, will be found of essential service. The structural character of the Calton, Salisbury Craigs, and Arthur's Seat, it is believed, cannot be satisfactorily determined without the simple guide we are here endeavouring to point out. Indeed, by neglecting this guide, Arthur's Seat has long been a stumblingblock to the student, and even to a few who consider themselves as belonging to a higher class. The weathering and abrading influences, however, may sometimes be so conjoined in the same field as to require an acquaintance with both agents for the comprehension of appearances. Thus, in tracing the stretch of the soft and hard strata constituting Sampson's Grave, and having become satisfied of their direction, one is suddenly met by a valley of abrasion, in which the Egg Pond is situate, cutting the weathered and partially denuded hollows nearly at right angles.

As an instance of the effects resulting from overlooking the hollows by weathering, which invariably indicate differences either in materials or state of aggregation of the rocks, we may here notice Inch Mickery. Mr Rhind, when describing this "rather a bare, barren rock," says, "The rock here is the same as Cramond Island," and consequently "formed of one solid rock of syenitic greenstone" (*Excursions*, p. 78.) Mr Cunningham, who seems equally to have examined it autoptically, says of Cramond, Mickery, &c., "From being entirely formed of trap, however, they exhibit nothing interesting" (*Geology of the Lothians*, p. 76). Yet Mickery will exhibit to the student, under the guidance of the simple truths here recommended, an interesting series of *sedimentary strata* separating the mass of greenstone into two beds, or forming a valley analogous to the transverse one of Inchcolm.

Let us now trace the character of those hollows and eminences of the district which illustrate, in a very remarkable manner, the great changes which have taken place, and the agents which have exercised their influence. If a line be extended from the southern extremity of Corstorphine Hill to the Register Office, or James' Square, it shall skirt a platform of gravel, till, and rocks constituting the north side of an extensive valley, and which is prolonged to the sea. Towards the middle of its course, where the valley is considerably contracted, it is bounded on the south by the high ground at the Haymarket, Gardner's Crescent being 228 feet above high-water mark, and Charlotte Square, on the north, elevated 205 feet. For the present we leave out of view the ravine at Coltbridge, and the inequalities of the *Water of Leith*, and other valleys to the north of this first line, because these belong to another system of disintegration, to which we shall speedily advert.

On approaching Edinburgh from the west, the Castle Rock forms the most conspicuous object in the landscape, and is not less interesting in reference to its geological features. It is the commencement of a ridge, which descends in an easterly direction, and terminates at the Abbey of Holyrood. The Castle Rock, elevated above the low ground at the North Loch, or rather above the Well-house Tower, 287 feet, consists of hard whinstone or trap, and is well calculated to resist the destructive agency of water or atmospheric changes. It is otherwise with the strata which come in contact with the Castle Rock, and which with an easterly dip, occupy the ridge of the High Street and Canongate. These consist of red sandstone, more or less slaty, and of very soft laminated marly clay. The character of the materials may be very easily ascertained by an inspection of the very fine section of the strata displayed on the south side of the Castle Hill. Had any violently disintegrating, abrading, or excavating power been exerted from the east, south, or north, the ridge of comparatively soft matter, extending from the Castle to Holyrood, must have been swept away, and the Castle Rock left as abrupt on its east as it now appears on its west side. But when we look at the precipitous faces of the Castle Rock on the south, north, and west sides, together with the very marked depression of the surface of the ground on all these sides, and its connection with the Corstorphine flat, any one, accustomed to examine the abrading and excavating effect of running water, would at once see proof, in the characters of this ridge, embracing its contents, form, and direction, that water was the modifying agent, and that its motion was in an easterly course. If we now attempt to trace the progress and effects of moving water in the direction now referred to, we see the Castle Rock setting its destructive agency at defiance ; and, while the soft materials on the west side were readily removed and a deep excavation formed around its sides of resistance, the soft materials, on the *lee side,* were greatly protected, although modified in form into a sloping ridge, with the excavation on each side now constituting the Grassmarket, Cowgate, and south back of the Canongate, on the south, and the North Loch and north back of the Canongate on the opposite side.

The excavating agency, thus modified by the Castle Rock, seems to have met with little interruption on the south side or Cowgate branch, but on the north side the appearances are of a different character. The valley of the North Loch, a continuation of the Corstorphine valley, seems to terminate, at its eastern extremity, in the bluff, irregular cliffs of the Calton Hill. Here again we have a repetition of the same phenomena which led us to admit the agency of water, to infer the direction of its motion, and to track the course of its abrasion. The west, north, and south sides of the hill, towards the North

Loch, rise abruptly to a summit about 213 feet above the site of the old Trinity College Church, with a sloping ridge continued eastward by Carlton Terrace to the plain of Holyrood, to which we traced the Castle ridge. Towards the west or highest portion of the Calton ridge, of old termed the Caldton, the rocks consist of amygdaloid, tuff, and other materials calculated to resist the destructive agency of water; while in other directions the strata are composed of softer materials, as may be seen in the exposed foundations for buildings at the Royal Terrace, where beds of sandstone and shale are well exposed.

The trap rocks of the Calton Hill seem to have presented the same obstacle to the action of the water as the Castle Rock, and to have afforded a similar protection to the soft materials on the *lee side.* We thus find, in tracing the valley of the North Loch, after passing the Castle, that it is divided by the Calton Hill; and while the southern branch, to which we have already referred, is prolonged in the north back of the Canongate, the other, or northern branch, passes by Greenside towards Leith Walk.

These two ridges have so many common features as to indicate unequivocally a common origin. The western portion of each consists of a mass of hard rock, while the eastern is composed of soft materials. The hard portions have resisted or modified the progress of the destructive agent, while, by being of limited extent, the ridges of soft matter which they have protected are of correspondingly small dimensions. The *bifurcations* of the valleys, in connection with these protecting masses, at once indicate the relation of these appearances, so familiar even to ordinary observers, with the agency to which they have been referred. But in the immediate neighbourhood of the city there are other places, of easy access, where phenomena similar in character may be observed, but modified by local circumstances, yet of great geological interest.

Let the student who feels an interest in tracing those phenomena, so illustrative of physical geography, to which we have referred, betake himself, after examining the protecting influence of the Castle Rock and the Calton Hill, to Salisbury Craigs, where, if he asks suitable questions of nature, he will not fail to get responses well calculated to awaken his desires for beholding and tracing to a greater extent the wonders of lithology. The Salisbury Craigs seem to terminate at the southern extremity of the semicircular valley, where a footpath leads from the west into the Hunter's Bog. But between this footpath and the Raven's Craig, on the abrupt western face of Arthur's Seat, there is a low ridge of greenstone similar to the Craigs, of which it is a continuation, and termed from its position the HAUSE (or throat).*

Here the observer may trace the trap ridge of St Leonards, extending from Sampson's Ribs to Dumbie Dykes, and terminating in the Calton. The valley to the eastward is parallel to this ridge, and indicates the former agency, modified in its direction from west to east, to nearly south and north. This valley occurs between St Leonards and Salisbury Craigs, and is joined at the south back of the Canongate by the Cowgate branch of the valley already referred to, having been continued through soft materials, occupying a part of the ridge of which the Calton Hill and Dumbie Dykes are portions. The soft materials of this valley of St Leonard's were probably similar to those which have been exposed at the Royal Terrace, of which, indeed, they seem to be extensions, resting and covered by the trap; while it is to be particularly noticed that the valley becomes narrow, and terminates just where the harder beds of whinstone approximate.

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* It is not our object to describe the beauties of the scenery, as viewed from the Hause, either on the west side towards Newington or eastwards by Lochend, Inchkeith, and the Fife coast, although few spots in the neighbourhood of Edinburgh could be selected combining so much natural beauty; yet we cannot allow the opportunity to pass of censuring the Commissioners of Woods and Forests for their arrangements in reference to this lovely spot. Instead of conducting the Victoria Drive by a semicircular sweep along the base of the Raven's Crag, around the east side of the Hause, to effect its junction with the valley on the west, at the footpath on the extremity of Salisbury Craigs, and, in this course disclosing scenes which strangers and natives would have gazed on with delight, the Commissioners have carried the drive, after emerging from behind Simpson's Ribs, into a *deep cut in the sandstone*, where all view of the surrounding country is cut off, and where the stranger must be contented with looking on clay banks or the jagged beds of rock, until he is conveyed into the valley of St Leonard's. Apart altogether from the want of taste which was displayed, or the total disregard of the pleasure of visitors, the course selected was the most expensive, owing to the materials to be excavated and their cartage, together with the requisite drainage; and it has given to the road a steepness which by the other and obviously better course would have been greatly reduced. Although this blunder has been perpetrated, in opposition to remonstrances which we made at the time, it is not likely that the inhabitants of Edinburgh will suffer it long to disgrace the neighbourhood, or that those presently in power will be disposed to resist the appeal.

The valley of the Hunter's Bog is still more instructive. It occupies a position between the whinstone of Salisbury Craigs on the west side, and the Raven's Craig and Dasses on the east, and has been scooped out of the comparatively soft materials of sandstone and clay, the remaining portions of which may yet be seen at the quarries on the west side. Like the valley on the east of St Leonards, it contracts where the hard rock of Salisbury Craigs approaches that of Arthur's Seat, but at its northern extremity it exhibits a peculiarity which establishes a resemblance to that of the Haymarket or the North Loch—it bifurcates, and the hard rock, with its slope in the direction of the valley, constituting the HAGGIS-NOW, has modified the excavating agency precisely in the same manner as the Castle Rock and the Calton Hill, indicating, at the same time, that the direction of the motion was south-westerly.

Behind the Dasses and the Lang-raw, which form the eastern margin of the Hunter's Bog, is the singular valley termed the DRY DAM, which takes its rise between the Nether Hill and the summit of Arthur's Seat, follows a course nearly parallel with the Hunter's Bog, and bifurcates at St Anthony's Chapel, where it terminates, after uniting with the south branch of the Hunter's Bog at the WELL. Towards the head of the DRY DAM there is another valley which opens upon Dunsappie, where we have the excavation and bifurcation analogous to the cases which have been already referred to, the softer materials having occupied the place of excavation.

On the Whinney Hill of Arthur's Seat there are tolerably distinct indications of what seem in their general character to resemble a river course. Running water in a channel has not only a tendency, from lateral deflections, to form a zig-zag course, but also from vertical deflections to produce a succession of fords and pools or *reaches*. Traces of such reaches may be observed at Sampson's Grave and other places of the hill.*

Excavations such as Duddingstone Loch, Hunter's Bog, Dunsappie, and Lochend, point in a very obvious manner to this scooping power of deflected or resisted currents; although the formation of some of these hollows may be traced to different agencies, in as far as the retention of water is concerned. I may here observe, that in forming the new embankment at Dunsappie, traces of an earlier one were very distinct, so that an old compensation pond for the use of Holyrood House may now be hastily conceived as the site of an ancient lake. Lochend, Duddingstone, and the Meadows were probably converted into lochs by the unequal distribution of the superficial strata.

The whole phenomena which have thus been briefly noticed, appear to indicate, and not unequivocally, *water moving over the surface in an easterly direction with great impetuosity.* In order to account for this appearance, it has become fashionable of late, with a certain class of speculative geologists, to assume the submergence of our island in the ocean, at which time the current, then prevailing, is supposed to have formed the hollows to which we have been referring—these oceanic currents having been assisted by huge icebergs exerting their crushing and abrading power. The elevation of the land is by such observers imagined to have taken place by sudden jerks or paroxysms, proofs of which are pointed out in certain levels or plains assumed to be *sea margins*, and in the occurrence of sea shells in what are termed *raised beaches*.

We are not in a position at this stage of the inquiry to enter on the discussion of the questions connected with this supposed submergence and elevation, because, without an attentive examination of the materials occurring on the surface, and their modes of distribution, inquiries too frequently executed in a careless manner, the imagination is very apt to mislead the judgment. But when we shall have instituted such inquiries into the superficial strata of the neighbourhood, the examination of such notions will not be otherwise than a pleasing and easy task. In the mean time, the character of the valleys of abrasion,—the hard abrupt rocks facing the west, and the soft protected matter on the *lee side,* constituting what Sir James Hall termed the *craig and tail,* warrant us in disregarding the agency of oceanic currents. The tides of the sea act on all sides of a protuberance or island, on account of ripple action, even although the flood and ebb movements may differ in intensity. The Bass, the May, and Inchkeith exhibit no craig and tail appearances, nor is there a trace of such a character in the islands situate in the most rapid of our tideways—the Pentland Firth. If the Castle, the Calton, and Arthur's Seat had ever experienced the fate of the aborigines, and been "beaten, bobbed, and thumped," whether by tidal waves and currents, or icebergs vast, even granting that there was little wind in those days to generate destructive ripple waves, no appearance of a *lee side* would have been traceable, equalling in magnitude and distinctness the phenomena which have been indicated. If we call to our assistence the Gulf stream, it will not furnish us with analogous phenomena, as the Hebrides, the Orkneys, and Zetland abundantly testify.

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* Well-marked traces of *river reaches* occur in other districts, as in the serpentine rock to the east of the Buck of Cabrach, and in a more river-like course through a wood, on the east side of the gneiss rock of Tyrebagger, Aberdeenshire.

CHAPTER III.

Remains of Abrasion—Effects of Floods—Examples of Rubbed and Scratched Surfaces—Deceptive Appearances—Crumpled Surfaces—Fissures and Flaws.

In the last chapter the conclusion was arrived at, that water had passed over the surface of the district with great velocity, and in an easterly direction, probably at successive intervals, plowing up the soft materials of the rocks, and removing them, modifying by abrasion the harder portions, and thus giving to the valleys and hills their peculiar configuration. Currents on a smaller scale and acting suddenly have frequently taken place, although their peculiar effects have too seldom been recorded in sufficient detail. The following cases, however, may serve as a guide to our further inquiries into a series of phenomena of the most interesting kind.

Sir James Hall, by whom this department of Natural Science was most successfully introduced and illustrated upwards of forty years ago, has put on record that " a country house (in a neighbouring county to Berwick) situated on the slope of a hill, was assailed by a sudden torrent of water, produced by the sudden bursting of a thunder-storm on the hill above. The impetuosity of the stream was such, that it forced its way through the under storey of the house, carrying along with it quantities of sand and gravel and stones of considerable bulk. Happening to be on the spot a few weeks after the accident took place, I observed that every stone, as it passed through the house, had left a rut or scratch behind it upon the flags over which it passed." (Trans. Royal Soc. Edin .vol. vii. p. 128.)

Mr Smith of Jordan Hill, who has laboured zealously and successfully in this department of petralogy, has stated—" At

Greenock in 1834, I witnessed the effects of an inundation, caused by the breaking down of the head of a reservoir, in which upwards of thirty lives were destroyed. In its track to the sea, it exhibited all the phenomena of diluvial action. The streets and walls were marked with furrows; masses of stone, and even of cast iron, were mixed up with clay and gravel, without regard to their gravity; whilst within the houses everything was covered with a thick layer of fine silt, exactly as in the diluvial caves." (Wern. Mem. vol. viii. p. 65.)

Mr David Milne Home of Milnegraden, to whose important labours we have already referred, says,—"In the Tower Burn near Dunglass, there was lately a railway debacle, owing to the breaking down of a high embankment by water accumulating behind it. The torrent carried down with it large quantities of earth and stones; in the course of the passage of which, innumerable scratches and ruts were produced on the solid rock and on large blocks of stone lying in the channel of the burn. I have procured one of the hardest of these blocks, composed of greywacke, which was scratched and rutted on this occasion. It will be found to have on its upper surface at least fifty striæ, all more or less parallel, and some of them of considerable depth. It is deposited in the Museum of the Society. The direction of the striæ on this and other blocks, I found to be coincident with what had been the course of the torrent which passed over them. The striæ thus produced are the more remarkable that they were not on a surface of solid rock, but on a block or boulder capable of yielding to an impulse." (Parallel Roads of Lochaber, p. 42.)

The facts which we have now referred to seem naturally to suggest the question, Do the *rocks, by their rubbed and scratched surfaces, furnish proof that a torrent of water has passed over them, carrying sand and stones in its career; and do these dressed surfaces indicate the direction in which the current flowed?* Should satisfactory answers be obtained to these inquiries, and coincident with the conclusion already reached, from the consideration of the direction of the valleys and the shape of the hills, we shall be in a condition prepared to examine the other effects produced by this mighty agent. Fortunately the neighbourhood of Edinburgh presents many well-marked examples of dressed surfaces, neither difficult of access nor of doubtful interpretation. Let us begin with the nearest, or those which may be regarded as within the city.

1. *Calton Hill.*—There are two very distinct examples of dressed surfaces on this hill, the localities of which are of easy detection. The first occurs on the left side of the footpath which ascends from the west end of the Royal Terrace, or Greenside Church, to the high part of the hill. About the middle of the path, and ten yards west from the seat, a hummock of rock, of amygdaloidal porphyry, presents itself on the margin of the path, and is a continuation of the *Monument-bed.* The top of this mass is obviously rubbed even, and several parallel shallow grooves may be observed in a direction nearly from west to east by compass. The western side of this dressed surface bears unequivocal marks of its having been the most exposed portion, and, as the weather side, to have been "beaten, bobbed, and thumped." This abraded surface, on its summit and towards the grassy margin, must not be confounded with the smooth and somewhat waved face of the surface of the rock which slopes towards the seat at nearly 20°. This last appearance is unnected with abrasion, and belongs to the structural or concretionary character of the bed.

When the summit of this north walk, ascending from the east, is reached, another example of a dressed surface presents itself in the angle formed by the junction of the lower and upper north walks and to the north-east of the Jews' burial-ground—the rock being a continuation of the *Observatory-bed.* Here the summit of the exposed surface is dressed and scratched as in the last example, but the striæ proceed from the north of west more decidedly. They are not at different parts parallel, those on the west portion being about W. by N., while some on the east portion reach beyond W.N.W. There is here likewise a smoothed waved surface sloping northwards and down towards the footpath, which is due to the concretionary character of the rock. But this deceptive appearance may be more satisfactorily witnessed on the south side of the upper north walk near the seat, and a little to the east of Nelson's Monument, where the spherical concretionary masses are displayed on a large scale.

2. *Victoria Drive at Samson's Ribs.*—On the left side of the road in going eastward, a hummock of rock has been judiciously left projecting a little from the line of the retaining wall which rests upon it. On its upper surface there is here the same dressing in the direction nearly of W. to E., with the most abraded or weather side facing the west. This example of dressing is singular in this respect, that we have on its edge scratched lines on a sloping or vertical face, nearly parallel with the horizon. The appearance of horizonality must be difficult to account for by those who elevate and depress the land as suits their purpose. This interesting feature of abrasions, although only exemplified in this single instance as yet observed in our neighbourhood, has been witnessed by me on the north side of a cliff of limestone exposed in the course of quarrying operations at Hedderwick to the north of Brechin; and on the exposed northern face of North Berwick Law. We have thus scratches parallel with the horizon, extending over a considerable area, and in both cases, but especially the former, the dressing agent had acted from the west.

3. *Salisbury Craigs.*—On ascending the crest of the Craigs from the south-east at the Hause, until the margin of the great quarry be reached, the road from the Queen's Park to Newington will be opened opposite to a pretty large surface of the greenstone rock sloping towards the Hunter's Bog. One set of scratches may be observed running nearly E. by W., and the dressing is remarkable as occurring on the somewhat sheltered side of the hill, assuming the action from the west. Other scratches pass from W. by N., while a third group, and apparently the newest, run from N.W. This example was first noticed by Mr Maclaren.

4. *Egg Pond.*—This locality may be reached with the greatest certainty by ascending from Mushet's Cairn to the highest point of the ridge N.E. of St Anthony's Chapel, and at the northern extremity of Samson's Grave. On the south side

of this interesting little basin, the basaltic rock has its surface dressed, the weather side obviously to the west, the quarter to which the striæ point. In a basalt hummock, to the westward of the basin, there is one tolerably distinct dressed surface, but the striæ here have a direction from W.N.W.

5. *Joppa.*—In proceeding from the village along the shore southwards to the Saltpans, the first rock of sandstone which appears on the beach is dressed, the striæ running between W. by S. and W.S.W., the weather side being westward. In the former examples the loose soil, or debris, was in contact with the dressed surface. Here, however, the old till, or boulder clay, rests immediately on the scratched surface, and the striæ may be traced continuously underneath the covering which has protected them from atmospheric influence. This covering seems to have extended, at no remote period, much farther eastward, as dressed surfaces may be observed on the sandstone, where uncovered by the tide, and indicates the destructive encroachment of the sea. Indeed the wasting of the land on the shore is but too apparent from the Maitland Burn to the Black Rocks. These, from exhibiting traces of dressed surfaces with tilt in the neighbourhood, were probably at a comparatively recent date continuous with the present coast.*

6. *Granton.*—About 130 yards to the westward of the pier, and close to the retaining-wall, there is a remarkably good example of a dressed surface of sandstone, the west or exposed side being very distinctly indicated. The scratches run nearly W. or W. by S. This is perhaps the best example in the neighbourhood of Edinburgh, as the dressed surface is of considerable extent, and, we may add, preserved, for its scientific value, by the considerate zeal of Mr Howkins, civil engineer, Granton. When I first detected this example there was but a small portion exposed, but the boulder clay which formed the immediate covering of the rocks has now been greatly washed

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* The wasting influence of the sea seems here to excite no alarm, for the boulders of greenstone, originally washed out of the clay, which occur abundantly on the beach, are being carted off to form road metal, instead of being left or arranged to act as break-waters or protectors.

away, and a wall erected to save farther encroachment from the sea. A little to the westward, however, this clay may still be detected in its original position.

These six examples, which cannot be too strongly recommended to the study of the earnest observer, are at present in existence, and of easy access. Other and equally instructive examples are from time to time occurring, and may be looked for whenever the rock is *tirred*, or the clay or gravel removed, preparatory to quarrying operations. Thus fine examples were displayed a few years ago on the trap at St Margaret's Station of the North British Railway. Similar appearances occurred at the Grange Cemetery, at Burdiehouse, Craigleith, and Redhall. At the latter quarry the surface of the sandstone, on the *cover* being removed, presented one set of scratches, directed W. and E. and another S.W. Other operations at the same place may again unfold similar appearances.

Before closing the results of these personal observations on the dressed surfaces of the neighbourhood, we shall notice two other examples of considerable interest from their peculiarities.

7. *Torduff.*—This hill consists of feldspathic rocks, and is situate to the westward of Bonally near Colinton. On the south-west side a considerable extent of dressed surface was detected ten years ago, and pointed out at the time to Lord Cockburn, Sir Charles Lyell, Professor Pillans, and Mr Maclaren. There is no appearance of the rock having been recently covered by clay or gravel, so that the preservation of the scratches must be referred to the hardness of the material, which is but feebly acted upon by the weather.

8. *Thomson's Walls.*—This locality is to the eastward of the east Cairnhill in the Pentlands, and to the west of the Compensation Dam on the Esk, above Carlops.* Here a portion

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* Dr Pennecuik in his History of Tweeddale (p. 112, 2d edition, 1815), refers to "an house called Esk-head, near the top of a bleak and barren mountain, with a park and sort of a little garden, with a stone and lime dyke, built within these four years by the deceast Mr William Thomson, Writer to the Signet, a wild and remarkable habitation, hard to come by, bleak and barren, in view of the mansion of no other mortal." The ruins still visible are termed Thomson's Walls or *Folly*.

of the sandstone rocks had been exposed by *tirring* for quarrying operations, and, immediately underneath the soil, a thin layer of yellowish clay, with stones, had protected the surface of the rocks from atmospheric influence. The scratches were from west to east, and constitute the most elevated example which we have as yet detected, the place being, according to Knox's Map of Mid-Lothian, 1400 feet above the level of the sea.

According to Sir James Hall, after reviewing his numerous observations, " the direction of the stream in the neighbourhood of Edinburgh, as indicated by the medium result of a number of observations, appears to have been from 10° S. of W. to 10° N. of E. by true bearings taken with a needle, and allowing 27½° W. of N. as variation (1812)." The examples which he has given are chiefly in connection with Corstorphine Hill, a map of which, with the localities marked, he has added to his paper already referred to (Edin. Trans. vol. vii. 212). We insert the following as indicating the attention which he bestowed on the appearances.

No. 1.	Craigleith Quarry, from	W. 5° S. to E. 5° N.
2.	Maiden Craig,	W. 5° S.
3.	Ravelstone old farm-yard,	W. due.
4.	Well Craig near Craigcrook,	W. 20° S.
5.	Craighouse Quarry,	W. 5° S.
6.	North of ruin at Dean of North Clermiston,	W. 10° S.
7.	North-east of cottages there,	W. 10° S.
8.	Middle of the North Hill Park,	W. 10° S.
9.	South side of ditto,	W. 10° S.
10.	Bare space west of summit,	W. 10° S.
11.	Summit of the hill,	W. 10° S.
12.	South-east corner of South Mid-Hill Park,	W. 15° S.
13.	Summer-house on second summit, belonging to Ravelstone,	W. 15° S.
14.	Sheep Park of Corstorphine Hill House,	W. 8° S.
15.	Below Murrayfield Quarry, east of Belmont,	W. 15° S.
16.	Dickson's Craig, Barnbugle,	W. 3° S.
17.	Redhall,	W. 8° S.
18.	Ravelrig,	W. 15° S.
19.	Kingston, near N. Berwick,	W. 15° S.

Before dismissing this part of the subject, it seems expedient to advert to certain appearances which frequently occur in rocks, and which may be mistaken for proofs of dressing by a hasty or prejudiced observer, and in addition to a few warnings already given on the subject.

1. *Crumpled Surfaces.*—We do not here refer to the variety of this structural character of beds, denominated *Ripple-marks,* because the grooves and ridges anastomose in a manner totally distinct from the nearly parallel scratches which we have been considering. But when the crumples observe a particular direction, and consist of narrow parallel ridges, they may readily suggest a dressed surface. A fine example of this character occurs in Arthur's Seat, towards the northern extremity of the porphyry bed denominated the *Dasses,* and more recently by Mr Maclaren, the *Bog Crag.* This bed stretches nearly S. by W., with a gentle rise of about 15° from its northern extremity, where it sinks under the grass at a short distance from the road leading to St Anthony's Well, along the west side of the Haggis-Now. The easterly dip is about 23°. Considerable portions of the surface, six to eight feet in breadth, are bare and exposed to the weather, immediately adjoining its western edge. This surface is marked by numerous small parallel ridges, seldom reaching to two inches in breadth, very shallow, scarcely exceeding half an inch in depth, occasionally preserving for a couple of yards their distinctive character, at other times slightly waved, but, throughout, exhibiting generally a continuous parallel linear arrangement. The line of greatest slope, as indicated by the *slide* of the boys at the spot, is nearly W. and E., but the direction of the groves is about N.N.W. or perhaps more nearly 20° W., and they incline to the horizon at about 10° to the east. At a little distance from the margin of the Dass where the crumpled surfaces are exposed, a quantity of debris from the Langraw, about twenty-five yards distant to the east, the equivalent of the Loch craig on the south side of the hills, conceals the covering beds of sandstone, the equivalent of those of Windy Gowl, which there rest on the Hangman's Knoll, the equivalent of the Dasses.

The shallowness of the grooves, the very near approach to equality of size, and their direction being different from that of the valley (the Hunter's Bog) in which they occur, lead us at once to reject the idea of an iceberg or glacier, nor can we admit of a current of water moving in any direction as presenting stronger claims. The proximity of the grooved surface to a high impending ridge to which the lines are neither parallel nor perpendicular, likewise renders such causes inadequate. To an eye accustomed to look at dressed surfaces, the absence of that *even rubbed ground on which the scratches are impressed,* will readily be perceived. When I read a description of this appearance before the Royal Society of Edinburgh (see *Proceedings,* 2d Feb. 1846), it was supposed by some volcanists, that as the bed of trap was a lava, these crumplings took place in its molten state, when flowing over or insinuating itself among the sedimentary beds. But upon inquiring more extensively into the phenomena, it will be found that it is a structural character, not exclusively exhibited by rocks of a supposed igneous origin. Thus, at Joppa quarry, a bed of the sandstone exhibited on the surface parallel markings as distinct as those of the Dasses. The bed occurred on the south side of the north portion of the quarry, and near to the place where the sigillarian stems (probably *S. pachyderma*) are seen in the sandstone covering the ancient soil on which they grew.

It is seldom, indeed, that we find the contiguous surfaces of the strata of a bed approaching to even. They are generally more or less waved, and these crumples are more frequently displayed on a larger scale than either at the Dasses or at Joppa. Thus, at the old quarry at Salisbury Craigs, which has been already noticed as the locality of dressed rock, the surfaces of the strata of greenstone, which have been exposed by the quarriers, display the crumples with tolerable distinctness. But they are nowhere exhibited more satisfactorily than at the glen of North Clermiston, and at the place marked No. VI. and VII. by Sir James Hall on his map. The crumplings here can be traced on the surface of a stratum of the soft decomposing greenstone, passing under the covering stratum—the under surface of the imposed bed being a cast of the waved surface of the one on which it rests. It is probable that some of the crumpled surfaces at this place have been mistaken for dressed ones; and the cast of one of these in plaster, presented to the Royal Society by Sir James, serves greatly to confirm the suspicion. We may here add, that very well marked examples of parallel crumples are at present observable in the surfaces of the strata of clinkstone at Blackford, and of the sandstone at the new quarry at Granton.

2. *Surfaces of Fissures.*—By *fissure* we mean a fracture or dislocation, extending through several beds, and to an unknown depth. When such fractures are attended with displacement, they are termed *slips;* when the fissures have their margins squeezed and broken into fragments in a somewhat irregular manner, they are termed *troubles* by the miner; and when sufficiently wide, and filled with foreign matter, they are called *dykes.* The surfaces of rock which form the sides of fissures denominated *slips* are very frequently, especially on the ends of the harder beds, rubbed and scratched in a manner very closely resembling the dressed surfaces which we have been considering. In almost all the sandstone quarries of the neighbourhood such rubbed surfaces may occasionally be observed. Some rather indistinct examples occur in the greenstone bed of Salisbury Craigs, towards the northern extremity of the ridge. But the most expressive example, presently accessible, occurs at the south-east corner of the Castle rock, where the old red sandstone beds bend down to underlie the trap. A large surface facing the east may here be studied to advantage. Such fissures indicate very plainly that the fractured surfaces have been displaced, and, in the course of the change or subsequently, have been rubbed against each other. The position, however, of such faces, if carefully examined, will prevent their being confounded with *surface* dressings.*

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* The *Slickenside* of Derbyshire is a singular variety of the fissure as a dyke, in which the included matter is divided by one or two vertical planes, " whose polished surfaces are absolutely in contact with each other without the least degree of adhesion. These naturally polished surfaces are not truly flat, but in some degree waved, as if formed by a carpenter's plane, consisting of various members." (Whitehurt's *Inquiry into the Original State and Formation of the Earth*, p. 219. 2d Ed. 1786.) These features of slickenside, and other important ones noted by the original observer, indicate its diversity

3. *Surfaces of Flaws.*—When the breaks or fractures are *confined to a single bed,* and give no proof of displacement or sliding, I have been in the habit of calling them Flaws. (See *Proceedings of Royal Soc. Edin.*, 7th Feb. 1853.) They occur in all directions in the bed, separate, or united, with the opposite surfaces smooth and waved. In the soft materials, such as coal, steatite, or shale, these surfaces frequently exhibit a specular polish, and by colliers are termed *glazed backs.* These flaws have been referred to *shrinkage* from the escape of volatile matter, and their specular character to the *casting* or impression, under great pressure, from a liquid or gaseous surface—a feature in which they resemble the Derbyshire slickenside. The position of flaws *in* the bed, and the grooved surface traceable into the rock, may readily indicate its difference from a dressed surface. But as the two appearances, however different in their origin and character, have been confounded, I shall here make a reference to two instructive localities.

In the bed of porphyry exposed on the north side of the road leading to the Calton by the back of the High School, many characteristic smooth striated surfaces of flaws are exhibited, which evidently belong to the structural character of the rock, and are unconnected with surface dressing. But the most magnificent example in the hill is on the south high walk behind the seat to the east of the monument in the Observatory-bed, to which we have already referred. The other example occurs near the dressed surface on the Victoria Road above Samson's Ribs. In going eastward, after emerging from St Leonard's valley, the first rock on the right is an amygdaloid full of flaws. A few yards farther eastward, on the opposite side of the road, the rubbed surface No. 2 occurs, so that the two phenomena can be satisfactorily compared.

The last marked surface to which we shall make reference, is one exhibiting characters so very remarkable as to have perplexed, in no ordinary degree, several of our local geologists

from the rubbed surface of displaced fractures, although the term be frequently but incautiously employed when referring to them. We are not aware of any genuine examples of slickenside occurring in Scotland.

—viz. Blackford Hill. Mr Maclaren, in calling attention to the phenomenon, states, that "the most satisfactory specimen (glacial marks) near Edinburgh is in the quarry on the south side of Blackford Hill, at a place laid open a few years ago, where the rock leans forward, forming a sort of vault. The surface of the clinkstone here, for a space of ten or twelve feet in length, is smooth, and marked by striæ or scratches in a direction approximating to horizontal. We accompanied M. Agassiz to the spot about two months ago; he had expressed doubts as to some other supposed marks of glacial action near the city, but on seeing those on Blackford quarry, he instantly exclaimed, 'that is the work of ice.'"—*Scotsman*, Dec. 1840. Mr Milne Home describes the same phenomenon in a somewhat different way—"At the base of the cliff there is an accumulation of gravel, consisting chiefly of felspar, but containing pieces of coal-sandstone not much rounded. Above the gravel is a bed of sand which is in contact with the overhanging face of the rocks. The upper part of the sand, next to the rock, contains numerous pieces of shale and coal. It is proper to add, that on clearing away the sand, I found the face of the cliff very much rutted and scratched. The direction of the scratches is nearly east and west. I learnt from a labourer who had worked in the quarry for fifteen years, that this deposit of sand and gravel when it was discovered, extended in an east and west direction, *i. e.*, along the face of the cliff about 120 yards, and in a north and south direction, or from the face of the cliff about 50 yards. The base of this cliff is about 320 feet above the sea. It appears to me that the gravel and sand in the above locality, must have been brought from the eastward."—*Lothian Coal Fields*, p. 75.

In these two quotations, descriptive of the same example of an abraded surface, I have proof, after actual examination, of very defective observation as well as unwarrantable deductions. The abraded rock is not clinkstone, as Mr Maclaren states, but a trap tuff, which seems to be graduating into the old red sandstone conglomerate, on which the hill probably rests, and which stretches westward from Liberton, giving occasion to the valley between Blackford, and Braid. The scratches are not "*in a direction approximating to horizontal,*" for they have various inclinations from horizontal to 60°. The direction of the scratches cannot be "*nearly east and west,*" as stated by Mr Milne Home, for the dressed surface has a direction nearly from N.W to S.E., and faces the S.W. The protuberances or irregularities of the abraded surface are all rounded on the N.W. side, giving unequivocal proof that the abrading agent acted from that quarter. Even assuming that the gravel and sand were not originally the abrading agents, the statement of Mr Milne, that these "*must have been brought from the eastward,*" is improbable, when the position of the face of the cliff, as already noticed, and the materials of the mass are kept in view. The sand is very distinctly stratified nearly horizontally or slightly inclined, and adheres with considerable firmness to the surface of the rock. It is a natural concrete, the particles being held together by carbonate of lime, probably due to infiltration. In some places the abraded face is nearly vertical, in others it slopes northwards underneath the projecting mass at an angle of 50°.

The abraded surface has not been acted upon uniformly, like the *dressed* ones which have now been considered. It exhibits an irregular series of dimples with shallow grooves of small extent, as if the abrading agents had been subjected to frequent shiftings and intermittent pressures. While some of these acted on the vertical face, others have been squeezed under the projecting cliff, and have escaped by a downward course. Floating ice and driven gravel may, in conjunction, have furnished such a result, but I feel warranted in concluding, that, if the examples of *dressed surfaces* which have been enumerated, were produced by glaciers or icebergs, the Blackford hill example is not entitled to a place among them. It seems to be a local phenomenon, connected with the Braid burn, and is probably of more recent formation than the *dressings.*

Several years before the description of this abraded surface by Mr Maclaren and Mr Milne Home appeared, but overlooked by these authors, Mr Rhind had referred to the phenomenon, and unhesitatingly indicated its mode of formation:—"The clinkstone, in a liquid mass, has evidently fallen on the bed of sand; for it presents the identical appearance that a similar mass of melted iron, when run upon sand would do. It is moulded into a round form, and leaves waving depressions on the sand. That portion of the sand, for about the thickness of a foot, in immediate contact with the clinkstone, is hardened into stone, and, when broken off, retains the impression of the rock above, without adhering to it closely." (*Excursions*, p. 61.) We refrain from commenting on such description and explanation.

The young observer should be on his guard against being deceived by different kinds of *weathered* surfaces, such as may be observed at almost every quarry. When the exposed portions of the rock have been acted upon by river currents, *drift sand*, or *sea gravel* thrown up by storms, the abrasion may be great, but will present an irregularity very different from the obvious levelness of a dressed surface. The exposed ends of the strata at the new quarry at Granton, where this spurious appearance was recently displayed, may be studied with advantage, for they have successfully deceived even experienced geologists.

Before leaving this part of the inquiry it may be noticed, that the *craig and tail*, and *the dressings*, coincide in their indications of the abrading agent having acted from the west. The other effects which it produced now require to be investigated.

CHAPTER IV.

Reluctance of Observers to study the recent Deposits—Classification of the matter resting on the Dressed Surfaces—The Staple of Walker—Diluvium and Alluvium of Phillips and Conybeare—Diluvial, Ante-diluvial, and Post-diluvial of Buckland—Eocene, Miocene, Older Pliocene and Newer Pliocene of Lyell—Superficial Deposits of Mr Home.

Satisfactory evidence seems to have been produced to prove that the direction of the valleys and the shape of the hills plainly indicate an impetuous body of water moving and acting in an easterly direction ; it may be at various and distant intervals. Proof has likewise been furnished that substances capable of scratching the solid rocks have been pressed along their cropping, and have left an even and rutted surface, with the ruts indicating the force to have acted from the west. These coincidences being recognised, we have now to consider what has become of the detached matter and the *rubbers* which were the agents of the abrasion. But this inquiry necessarily involves the consideration of all the stratified or unstratified materials which rest on the dressed surfaces, and to what extent these materials were derived from the operations of that destructive agent, to which we have already so frequently referred, either immediately or remotely. Nay more, have the strata, between the dressed surfaces and the present soil, a uniformity of structure and material ; or are there any proof of different agents having operated, and with intermittent energies, as displayed among the older deposits ? These questions are of deep interest, because not a few observers, while admitting a great diversity of structural character among the materials resting on the dressed surfaces, have usually made their selection, and while pleased with their explanation of the origin of certain beds, have, strangely enough, disregarded the vast amount of other materials left out of view. Besides, the deposits have been classified by empirical rules, and denominated by hypothetical terms, calculated to retard the study of perhaps the most interesting group of strata constituting the crust of the earth.

Upwards of thirty years ago, when referring to the changes which had taken place in our Fauna at or subsequent to these events, I remarked, that "It is customary with antiquarians in general, to delight to dwell on scenes which exhibit to their imagination the memorials of events nearly forgotten, or the transactions or customs of distant ages. Events of a more recent kind, or transactions which may be considered only in progress, do not arrest their attention, or, at least, fail to excite in their minds that deep interest which remoter subjects readily awaken. The public likewise feel and act much in the same manner. There is an importance attached to remote events, depending solely on their antiquity; while there is a vulgarity inseparable from recent events founded on the supposition of their being well-known. Geologists have long acted, and we fear still act, in a similar manner to antiquaries. The study of the character of the older strata (their position, structure, and ingredients), has been pursued with greater ardour than any researches which have been entered upon with the view of illustrating the connections of the newer deposits. Coal, sandstone, and limestone have been examined with zeal, while few have bestowed their attention on peat, sand, or marl. Similar practices have prevailed with regard to organic remains. Many have speculated concerning the structure and habits of those relics which occur in the solid strata, who have not deemed the study of the laws which regulate the living races, an object of much importance."

"We are not disposed to refer these well-known habits of the antiquary and geologist to any natural preference of the obscure to the extinct,—of subjects the relation of which, circumstances have rendered us incapable of determining, to those of a nature which may be illustrated with certainty. We are aware that antiquarian and geological speculations are usually engaged in from motives of amusement, and, when conducted in the usual manner, seldom fail to gratify their votaries. Were they to commence their investigations with a knowledge of recent events, and proceed by degrees to those of remoter times, their conclusions would assume a more imposing character, but the accompanying labour would be greatly increased. In speculating on the affinities of recent events, the understanding is ever occupied with facts; the imagination, thus in trammels, dare not indulge in its licentious wanderings. But when remote events are the subject of our contemplation, fancy becomes a valuable assistant by reuniting disjointed links, supplying that which is wanting, and enabling the mind to arrive at conclusions, which, without the labour of investigation, had probably been long anticipated." (Edinburgh Philosophical Journal, October 1824, p. 287).

These views, which were expressed in earnest, met with a very unwelcome reception, especially from those whose soaring hypothetical propensities they were intended to restrain. Nor at the present hour do the remarks seem uncalled for, since geologists are not agreed as to the principles of the nomenclature of the materials resting on the dressed surfaces, their relative antiquity, or the agents which were concerned in their distribution.

Dr Walker, professor of Natural History in the University of Edinburgh, to whom we have already referred, with all the respect due to great attainments, treated in his Lectures of STAPLE, or what is at present denominated *soil*, and also of the "loose *superficial nodules*" termed "BOULDER-STONES," better known at present as *Erratics*. At a later period, and at the date, in 1822, of the "Outlines of the Geology of England and Wales," by Conybeare and Phillips, the belief was all but universal, that a large portion of the materials covering the dressed surfaces, and even the dressings themselves, were generated and distributed by the Noachian deluge. Hence the division of these superficial deposits into DILUVIUM and ALLUVIUM, the former indicating the products of the FLOOD, the latter, materials of more recent origin.

The untenable conclusions announced by Cuvier, and so eagerly but rashly embraced by Jameson, Buckland, and many others, of "a recent and transient inundation" reckoned identical with the Flood described by Moses, paved the way to another classification of the superficial strata. "On these grounds (Dr Buckland says) I have felt myself fully justified in applying the epithet *Diluvial*, to the result of this great convulsion; of *Antediluvial*, to the state of things immediately preceding it; and *Postdiluvial*, or *Alluvial*, to that which succeeded it, and has continued to the present time." (Reliquiæ Diluvianæ, p. 2, 1823.)

Many circumstances led me to consider the GEOLOGICAL DELUGE, as interpreted by Baron Cuvier and Professor Buckland, inconsistent with the testimony of Moses and the phenomena of nature, and to disregard those divisions of the superficial strata founded on the assumption. (See Edinburgh Philosophical Journal, April 1826.)

When we consider that the oldest of these superficial beds enclose the remains of many animals belonging to species, the individuals of which are still surviving around us, associated with the remains of other species which no longer exist on the globe, we conclude that these extinct and still living beings were, at the period subsequent to the dressings, contemporaneous, as we now find them buried in the same grave. The badger, the red deer, the ox, and the goat, were living in Britain, and on the continent, when the mammoth, hippopotamus, and Irish elk were their associates. But none of all these have lived at an earlier period, for the organic remains of the so-called London clay and Paris basin beds are widely different, and belonged to species which evidently have suffered extinction, as a whole, prior to the creation of the existing races, and those which once co-existed along with them. Under the influence of these views all the materials superior to the dressings had been referred by me to the MODERN EPOCH (see Fleming's British Animals, p. xvi. 1828), while the pre-Adamic materials, with their organic contents, which immediately preceded them, were referred to under the denomination of PENULT EPOCH.

Five years after the adoption of this classification, Sir Charles Lyell, whom all recognise as an enlightened and earnest geologist, under the guidance of M. Deshayes of Paris, was led to regard "the proportional number of fossil species identical with the recent" as characteristic of the different groups. "The result then arrived at was, that in the lower tertiary strata, or those of London and Paris, there were about 3½ per cent. of species (of shells) identical with recent; in the middle tertiary of the Loire and Gironde about 17 per cent.; and in the upper tertiary or sub-Apennine beds from 35 to 50 per cent. In formations still more modern, some of which I had particularly studied in Sicily, where they attain a vast thickness and elevation above the sea, the number of species identical with those now living, was believed to be from 90 to 95 per cent. For the sake of clearness and brevity, I proposed to give short technical names to those four groups, or the periods to which they respectively belonged. I called the first or oldest of them, Eocene, the second, Miocene, the third, Older Pliocene, and the last or fourth, Newer Pliocene. The first of the above terms, Eocene, is derived from ἤως, eos, *dawn*, and καινος, cainos, *recent*, because the fossil shells of this period contain an extremely small proportion of living species, which may be looked upon as indicating the dawn of the existing state of the testaceous fauna, no recent species having been detected in the older or secondary rocks." (*Manual of Elementary Geology*, 5th Edit., p. 116.)

In the views connected with the preceding statement of Sir Charles Lyell, there are assumptions which may be considered objectionable in many respects. The first is, perhaps, the most startling, viz., That species have perished from off the earth by no sudden destruction, but by degrees, and that species have made their appearance to succeed them by no sudden creation, but imperceptibly.* If this notion be based on truth, it will cause a great modification in the commonly received opinions respecting chaos, and the commencement of the present races of animals on the globe. It leaves untouched, however, the proof of creative power, by acknowledging the appearance, from time to time, of *new species* on the earth, and it admits the destruction of species which has frequently prevailed. At present, however, we are chiefly concerned with the question, Is the notion consistent with scientific truth?

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* There is considerable difficulty in referring to any natural cause, capable of producing the extinction of life on the globe. Murrains, deluges, cold and

When we consider the quadrupeds, birds, reptiles. and fishes of the Paris and London basins, or of the eocene period of Lyell, we do not find that a single species had survived and been coeval with any of the existing races—so that there is no interval here—no dawn. The 96½ per cent. of shells, which constituted the testaceous fauna of the tertiary period, all perished, and only 3½ per cent. of their companions are supposed to have survived, so as to constitute the connecting links with the succeeding or modern group. But the identification

hot, dry and wet seasons, and the chace may have exercised a powerfully destructive influence on the individuals of a species or even on larger groups. But these agents seem too partial in their effects to be employed in the explanation of the phenomena. As the sun, our present source of light and heat, and the apparent supporter of life, is subject to change in reference to these qualities, we may perhaps find here a solution of the difficulty. When the surface of the sun is most luminous or has fewest spots, there is least heat, and, according to Sir William Herschell (Phil. Trans. 1801, p. 265), a bad harvest is the consequence, with high prices for wheat. When the spots are most numerous there is an abundant harvest, with consequent cheap bread. Now, were we to imagine the luminous atmosphere of the sun to increase to such an extent as to obstruct the radiation of the heat from the inferior surface, a glacial condition would prevail to the extinction of life on the globe. If, on the other hand, the luminous matter disappeared, and our sun became a *dark star*, a fate which observers have ascertained as having overtaken other stars in the firmament, then the withdrawing of the light would cause a biological epoch to cease. In such circumstances, plants would perish first, and the death of animals would speedily follow. If a new display of creative power were again to take place, we might expect, with the return of light, that plants would first be called into being, and subsequently animals, as dependent on them for food, either directly or indirectly. Such, according to the Mosaic Narrative, and in beautiful harmony with scientific truth, is the last recovery of the globe from a chaotic state, on the *dark star* becoming "as the sun when he goeth forth in his might;" and should these changes partake of a periodical character, the palæontological epochs may admit of a plausible, if not a satisfactory, explanation, whether these have been abrupt, or have partaken of a transitional character.

of these species of the *dawn* has not been established, nay, by competent observers, is doubted and controverted. When a very broad generalization, therefore, like the present, rests not on those objects which are distinct and recognisable, as the remains of *vertebrated* animals, but on *shells* macerated, and perhaps rubbed, and thus of doubtful character, and about the identification of which grave doubts prevail, we feel ourselves justified in avoiding a nomenclature and arrangement resting on such slender pretensions, and regulated by an empirical per-centage. Nor can the suspicion be avoided that the mixture of older with newer species, as those of the London clay, associated with those of the Crag, and produced by denudating and assorting agencies, may have been in haste misinterpreted, without even suspecting collectors of being ever either ignorant or guilty of deception.

I have long considered, and must again repeat, that there has been too great a tendency to select one or two beds of this group, which are here considered as constituting the Modern Epoch, and endeavouring to explain their origin and mode of formation, leaving the other beds as residual phenomena, not sufficiently important to demand consideration, or rather, it may be suspected, left out of view because assuming somewhat of an obstructive character. Thus we have *diluvium*, the result of a sudden flood; *moraines*, the effects of glaciers in abrading and assorting the materials; *drift*, northern drift or glacial drift, the effect of glaciers or icebergs, during the period when an arctic climate is said to have prevailed even in comparatively low latitudes.

Mr Milne Home, in his able Memoir on the Lothian Coal Fields, has endeavoured to classify these beds superior to the dressed surfaces, according to their position, a plan which we shall here present to our readers as a first and creditable attempt at generalization, exclusive of hypothesis:—

" In describing the different accumulations now referred to, it will lead to precision to follow a certain arrangement or classification. A very convenient one is suggested by the order in which they occur, in respect of position; certain of these deposits, with well-marked characters, being found throughout the district, always in the same relative positions. I think it possible to identify and individualise at least seven formations, each of which has separate characters in respect of texture, contents, and appearance,—and each of which belongs probably to different epochs. I will now enumerate them, beginning from the surface; and in doing so, I will, for the sake of convenience, designate them by particular terms.

(1.) The existing soil, supporting vegetation.
(2.) Upper covering of gravel and boulders.
(3.) Deposit of sand and shells.
(4.) Beds of fine sand.
(5.) Beds of fine clay.
(6.) Coarse gravel or stoney clay.
(7.) Lowest boulder-clay.
(8.) Beds of sand and gravel."

CHAPTER V.

Divisions of the Strata of the Modern Epoch—Taragmite series—Akumite series—Phanerite series—Basement Bed—Boulder Clay—Boulder Gravel—Sand—Proofs of Motion—Organisms.

In the last chapter I referred to several attempts to group the modern strata, which, apparently, have arisen as deductions from adopted opinions, rather than expressions of results from observed phenomena. In the classifications and terminology I am to adopt at present, a considerable reluctance has been experienced in abandoning the use of employed terms, particularly those of my respected friend Sir Charles Lyell. But these did not enable me to represent with sufficient distinctness the conclusions at which I had arrived, without a great risk of confounding them with others of a very different character, deduced from observations in more distant localities.

In the Edinburgh basin the modern strata seem capable of classification into three groups. The first or TARAGMITE SERIES, have been formed subsequently to the *dressings*, and, where present, repose upon them. They seem to have been formed when violent aqueous movements were taking place, and probably at a period when the state of our island was widely different from the present.* Although extensively distributed in Scotland, they have peculiar characters in different districts. Thus they are dark coloured on the coal-measures, red on the old red sandstone, and grey in some of the primary districts. The contents are derived from the neighbouring rocks, with occasionally masses transported from a considerable distance, but usually belonging to the river basin. The second or AKUMITE SERIES is chiefly characterised by its laminated clays and sands, and indicates the assorting power of water under circumstances of comparative tranquillity. It contains organic remains, many of which still live in the neighbourhood. It may be looked for wherever brick kilns have been erected. The PHANERITE SERIES[*] consists of deposits produced by causes in ordinary operation, and respecting the circumstances under which they have been produced little obscurity prevails.

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* Mr Bald of Alloa, whose intelligence, as a Mining Engineer, is so generally recognised, has stated:—"I have had very frequent opportunities of seeing this kind of cover laid open from the surface to the rock on which it rests, and have found it in thickness from a few inches to 160 feet, and have always remarked, that though it contained boulder-stones, and gravel of almost every kind of rock, and detached angular fragments of the adjoining rock stratification, I never had observed a single instance of an organic remain of any kind in it."—*Wern. Mem.* iv. p. 59.

The question, what has become of the detrital matter generated during those excavations and abrasions which have already been considered in detail, is one of great importance. That the period was one of *disturbance* will not admit of a doubt, and in passing to a state of tranquillity it may now be asked were the loose materials distributed according to any order? To answer this question satisfactorily, will require us to determine what were the abraded materials which first rested on the dressed surface, and served as a fundamental or supporting stratum to the subsequent deposits.

1. BASEMENT BED.—For several examples of dressed surfaces which have been noticed, the material termed boulder-clay has been stated as the cover. This, however, is not the oldest member of the Taragmite series, as several instances have occurred which indicate the existence and distribution of loose materials previous to the rocks being overlaid by this their more ordinary covering. Thus, at the sandstone quarry of Redhall, a large deposit of stratified sand and gravel was observed a few years ago resting on the bituminous shale which covered the sand-

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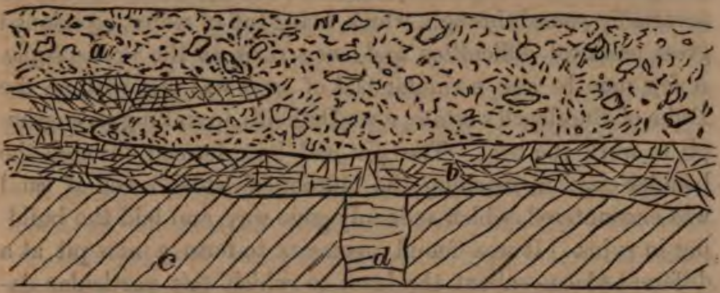
[*] Those who consider it necessary to trace the origin of these terms, which we have devised in order to avoid the employment of hypothetical ones, or such as have been used with different meanings, may be directed for Taragmite to *ταραγμα disturbance*, for Akumite to *ακυμος tranquil*, and for Phanerite to *φανερος evident*. At the same time it is freely admitted, that "when once the *thing* is known, inquiries into the etymology of the *word* expressing it, are rather curious than useful."—(Hailes.)

stone, and extending throughout a considerable space near to the place where the engine-house has since been erected. The relations of this mass of sand and gravel could not be determined on the north and west, although evidently resting in a hollow; but on the south it was observed reposing on the sandstone for several yards, and covered by the boulder-clay which rested on the rock in the other parts of the quarry. The clay seemed to have flowed over it quietly, or to have been deposited on it without occasioning any particular contortions in the sand. In Hailes Quarry, to the westward, a deposit of sand occurred under the clay and in a trough of the rock, commingled, however, with some slips of the clay and of peat, which rendered the phenomena somewhat obscure.

In executing the improvements on the Queensferry Road to the westward of Craigleith Quarry, several examples occurred of the clay resting on sand, and to some extent also stratified therewith. A similar case occurred in the *tirring* at the south-east corner of the quarry. In the excavations for the foundation of the houses on the north side of Charlotte Place, to the west of St George's Church, from two to three feet of angular fragments, or shivers of bituminous shale, rested immediately on the fixed strata of the same material. The boulder-clay rested on the shivers, and seemed to have been in motion from west to east, and at one place had squeezed a process of the shivers into its substance, so as to be above, below, and in front of the projection. In some places the shivers were slightly covered with sand interposed between them and the clay.

When the foundation for the gasometer on the south side of the Water of Leith, at Tanfield, was being dug, a similar display of the junction of the shivers with boulder-clay presented itself. In this case and the former, the shivers sometimes reached the length of three or four inches. Here they consisted of a light-coloured somewhat indurated slate-clay, occasionally arenaceous. This mass of fragments, forming a bed from two to three feet in thickness, rested on the edges or strata of apparently similar materials, and were covered by the boulder-clay. There was no transition between the one and the other, the line of junction being abrupt. At one place a tongue or spit of shivers ascended into the till, of nearly six feet in length, rising at about 20° and pointing eastward. See Fig. 1.

Fig. 1.



a The boulder-clay.
b Bed of shivers.
c Beds of slate-clay.
d Trap dyke, levelled by abrasion along with the shale on each side.

These observed examples, and perhaps others may soon occur in the neighbourhood, seem to intimate that some time elapsed between the *dressings* of the rocks and their being covered by the boulder-clay, and that immediately subsequent to the dressings, disintegration of the rocks took place, furnishing the sand and gravel of Redhall and Hailes, and the shivers at the two last-mentioned places. We have not as yet the means of determining to what extent Scotland has been overspread by this earliest member of the Taragmite series. We first observed it many years ago at the Bay of Nigg near Aberdeen, where we have had the pleasure of pointing it out to Agassiz and Buckland, Lyell, and Home. It there consists of sand and gravel resting on gneiss and covered by boulder-clay of a greyish colour. This in its turn is covered by gravel, in which we have found boulders of a boulder-clay, of a red colour, similar to the more southern Kincardine beds.

Mr Milne Home, in the Memoir already referred to, subsequently adduced several examples, the relation of which we shall here quote :—

"This deposit has been observed in several parts of the district, covering the edges of the stratified rocks. It prevails extensively in that part of the district situated between Dalkeith and Cowpits. Some years ago, coal was worked at the latter place; and in sinking various pits through the superficial clay and gravel, a bed of sand lying immediately on the rocks, was invariably passed through, which, being full of water, occasioned great practical difficulties, and even risks, to the work-people. A few months ago, a similar bed of sand was met with on the Duke of Buccleuch's estate, near Dalkeith, in sinking an engine-pit to work the coal. The pit had been formed through the boulder-clay, on reaching the bottom of which a bed of sand was encountered, which suddenly gave way, and laid the building in ruins. It was found necessary to form a new pit at a different place,—about the level to which this particular deposit reaches,—which appears to be about two hundred feet above the sea. At the place where the first pit was put down, the sand was nine feet thick, and between it and the rocks there was a mixture of sand and fine gravel, seven feet thick.

"At Joppa likewise (at the east end of the village, near the shore), the clay is separated from the subjacent coal-measures, by a bed of sand five or six feet thick. This sand-bed was found in the borings made for a particular coal-seam there, called the splint coal. The sand-bed covered this seam;—fragments of the coal were found in the sand, to the distance of ten yards from the crop or outburst of the seam. It is not unimportant to observe that, in the sand-bed, these fragments were all situated to the *west* of the coal-seam. Some fragments were also found at the bottom of the superjacent boulder-clay;—these were situated mostly to the east of the coal-seam.

"At Leith, and in the manufactory lately occupied by Mr Burstall, a well was sunk through the boulder-clay forty-five feet. A bed of sand and fine gravel was then reached, from which water immediately gushed up,—shewing that the bed was probably of considerable extent."

There is reason to suspect the want of continuity of this oldest stratum, which consists, at places not very remote, of very dissimilar materials. In the Joppa example above referred to by Mr Home, we see at present on the beach, as formerly stated, the boulder-clay resting immediately on the dressed sandstone, which, at a comparatively short distance, was found covered by sand. This *basement bed*, in this neighbourhood, consists of very different materials—sand and gravel in one place, or transported and assorted materials, and, in another, of angular shivers, resting in the immediate vicinity of the birth-place. Its formation, however, preceded the boulder-clay,—a deposit which has been to many, *pons asinorum*.

2. *Boulder-Clay*.—This well-known mass has been denominated till, old alluvial cover, and drift; but the term which we have selected, being destitute of hypothetical allusions, expresses merely an obvious character. Many instructive examples occur in the neighbourhood, and are of easy access, among which the following may be quoted:—The high bank on the east side of the road from the village of the Water of Leith to the east gate of the Dean Cemetery; the cliff on the shore westward of Leith Fort, and generally known as the *man-trap*; the shore line and along the beach from Seafield Baths east from Leith to the neighbourhood of the mouth of the Maitland burn; the *tirring* at the quarries of Redhall and Hailes. A visit to these and other places which may be mentioned, will not fail to give to the observer a more distinct conception of this singular aggregation of matter than words can furnish.

This remarkable deposit consists of a dark-coloured tenacious clay, as a paste, in which numerous angular and rounded stones are irregularly imbedded. When a portion of this paste is washed, it is found to consist of tough brick clay, fine sand, and a considerable number of grains of magnetic iron-ore. This last ingredient may often be observed on the beach, towards high-water mark, assorted by the tide or wind, as a black powder, not unlike coarse gunpowder, and was for a long time considered as coal-dust or cinders.

The stones contained in this clay vary from the size of gravel to masses of ten or fifteen tons weight. The largest known to us in this neighbourhood has been washed out of the clay near the mouth of the Foul Burn at Seafield. It forms a very prominent object on the beach, considerably within high-water mark, and is known as the *Head-band Button or Penny Bap.* Masses of greenstone are greatly more numerous than of any other rock. Portions of amygdaloid and of carboniferous or encrinite limestone may likewise be observed, along with different kinds of sandstone, coal, and bituminous shale.

The greenstone boulders are always rounded or water-worn, while the masses of limestone and sandstone are usually more decidedly angular. The shale is generally in small thin shivers, which appear not to have been exposed to the long-continued influence of an abrading agent.

The boulders of rock which must have travelled far, are few in number, although examples of granite, gness, and mica-slate may occasionally be observed. Specimens of trap similar to the Castle-rock have been repeatedly found to the eastward of the hill. But greenstones, similar to those of Salisbury Craigs and Corstorphine Hill, abound on the beach at Newhaven, Seafield, and the Maitland Burn. There is tolerably full proof that the boulders derive their origin from a westerly source.

Many of the greenstone boulders are not only rounded, and appear as if they had been *rolling* among hard matter, but are rubbed and scratched in a similar manner to the dressings already referred to. The direction of the striæ is frequently parallel with the longest axis of the block, although instances occasionally occur in which the scratches are transverse or oblique. The scratched blocks must have been pushed along some hard surface, and so involved as to prevent rotation, thus restricting the motion to *sliding.* After one face had been dressed and scratched, the boulder has evidently shifted position, and presented a second surface for dressing. In one boulder of indurated shale I counted *seven* dressed and scratched planes. The mass, however, indicated that while thus frequently shifted it was so embedded as to prevent rolling, otherwise these numerous faces would have been speedily obliterated.

It is a remarkable feature of this singular bed, that the boulders do not occur resting on one another at the bottom of the bed, where it reposes on the dressed rocks. They are scattered at unequal distances through the mass, almost always *apart*, and as numerous in the middle as towards the bottom of the bed. Their dressing and scratching could not, therefore, have taken place *in the bed*, where they must have been in relative rest, but previous to their *inclusion* in the clay paste or pulp.

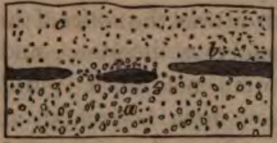
In some cases we find proof that different parts of the bed had been moving with different velocities, so as to have given in a particular plane an arrangement of the blocks in the direction of their least resistance, and of the scratchings of their surface. Evidence of such motion has been detected by Mr Hugh Miller on the beach at the Fregate Whins. Here, considerable patches of dressed and scratched stones, embedded in the clay, present a uniformity of line as exhibited between high and low water mark, indicating that they were fixed while the superincumbent mass was sliding over them. Even here, however, the scratched surfaces are not all arranged in the same direction; for while the prevailing line is easterly, boulders may be detected, apparently at the same plane, with an inclination nearly at right angles.

In the neighbourhood of Edinburgh, and particularly in the portions of the bed lowermost in position, as those near the shore level, there are no traces of intermittent action usually exhibited. In a few instances, however, we find a layer of larger boulders of unknown extent, occupying a horizontal position in the middle of the bed, and with the clay above and below, but filled with stones of considerably smaller dimensions. Thus, on making the excavation for the road to the east side of Donaldson's Hospital, a horizontal layer of boulders from two to three feet in diameter, could not fail to attract the notice of the observer. One of the blocks was carboniferous limestone, and had not travelled far, as its angles were not much *rounded*. This plane of blocks may not have been horizontal, although it appeared to be so, from having been viewed parallel with the stretch. During the excavations for the Adelphi Theatre at the head of Leith Walk, a similar layer of large boulders occurred in one plane in the ordinary boulder-clay, dipping, however, eastward at an angle of about fifteen degrees.*

Towards the top of the bed the clay becomes of a lighter colour, the proportion of sand increases, and distinct traces of horizontal stratification are readily discernible. The mass which, in its lower portions, offered great resistance to the pick, or even gunpowder, passes at last into a material which the railway contractor can easily overcome. In several localities of the neighbourhood, this transition from stiff clay with innumerable boulders, and of an unstratified appearance, into sandy clay, with small stones or rather gravel, and this again into fine stratified sand, may frequently be observed. It occurred, for example, behind the Theatre, previous to some building operations of the North British Railway, at excavations behind the Commercial Bank, at the British Linen Company, and in Register Street. The passage into the sand is so complete at Hailes Quarry, in the division to the south of the canal, as to afford the Sand Martin (*Hirundo riparia*) a convenient nestling place.

This upper or sandy portion of the boulder-clay exhibits well marked proofs of intermittency. Thus we have sometimes gravel interstratified with sand, or layers of rounded stones reaching to nearly a foot in diameter, with solitary masses of two or three feet in diameter. Among the beds of sand traces of silt or clayey mud, may very frequently be detected. In one place, to the south of Inverleith Cemetery, a thin layer of silt or dark-coloured clay occupied a horizontal position in the sand, and indicated at one spot, by its disjunction, the unequal pressure to which it had been subjected. See Fig. 2.

Fig. 2.



a Gravel.
b A layer of clay broken.
c Fine sands.

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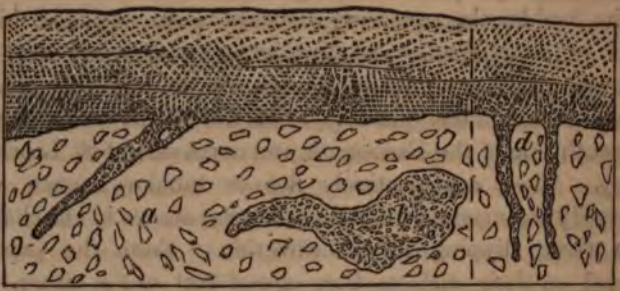
* In the boulder-clay of the Berwickshire coast, near the Cove, a horizontal layer of gravel occurs in the clay. The gravel is cemented by carbonate of

We have already noticed the proof of a motion from the west by the boulder-clay squeezing eastwards portions of the shivers which it overspread. At the junction above of the clay with the sand, angular fragments of sandstone frequently occur in considerable quantity, as in the recent excavation on the south side of the Canongate, and north side of St Leonard's valley. These comparatively flat or tabular masses, were *generally* arranged as we find similar flat stones in the channel of a river, dipping in one direction. From the pressure exerted on their surfaces, they cannot rest unless either lying horizontally or dipping in the direction whence the current flowed, or toward the source. In this case the current which assorted the boulders in the sand, had an easterly direction. It is difficult to find, in the boulder-clay itself, satisfactory examples sufficiently numerous, among the generally rounded blocks, from which to draw any such inference.

At the junction of the stiff boulder-clay with incumbent gravel, some very instructive appearances occasionally present themselves. Thus, in the *cutting* for the Edinburgh and Leith Railway at Bonnington, the gravel was seen overlapping the clay and dragging forward portions of it, just as we have described the boulder-clay acting on the shivers of shale which it covered at Tanfield. These tongues of gravel sinking into the clay, pointed eastward. In the same section, masses of the gravel of various shapes, had sunk into the clay, and become imbedded as pouches or bags therein. See Fig. 3. It frequently happens that films or plates of the gravel may be traced downwards into the clay for several feet or yards, indicating, like the other cases just referred to, a simultaneous soft state, with motion proceeding unequally. Some good examples at one time occurred at Register Street, and others recently existed near the mouth of the Maitland Burn, and at Redhall quarry.

lime, forming a natural concrete, blocks of which, lying on the beach, seem very indistructible. The bed is from a few inches to three feet in thickness, and may be traced along the sea-cliff for several miles.

Fig. 3.

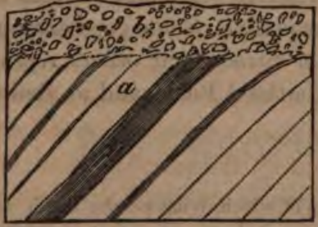


a Boulder-clay.
b A mass of gravel in the clay.
c A tongue of gravel from the bed of gravel and sand above.
d Films of gravel descending from the incumbent gravel into the boulder-clay.

When this boulder-clay rests upon rocks, it fills up the inequalities of the surface, as at the flooded quarry at Granton, or, as at Joppa quarry, it rests on the even horizontal crop of the highly inclined beds of sandstone and shale. In the last of these examples, the colour of the mass, and the appearance of the boulders in a layer, give indications that we are looking at the higher portion of the clayey part of the bed near to its passage into the sandy layers.

To the west of Gilmerton House, in a sandstone quarry to the south of the Parrot coal-pit, the crop of the beds is covered by a sandy boulder-clay, which has been in motion in an easterly direction, and by which it has squeezed or bent the decomposed ends of the beds of sandstone and shale towards the south-east. Fig. 4.

Fig. 4.



a Inclined beds of sandstone, slate-clay, and bituminous shale.
b Covering of boulder-clay.

It thus appears that the boulder-clay is part of a series of beds which must be regarded as constituting one formation, the stratification of the whole being conformable, and the transitions of one member into another of rather common occurrence. The inferior or oldest portion resting on the basement bed, is destitute of all traces of stratification, while the boulders are isolated in their clayey paste, which, on enveloping them, was so viscous as not to permit them to subside towards the bottom. The surfaces of many of the boulders are rubbed. This dressing could not take place in the bed, for the masses are not in contact. If before their mixing with the clay, then are we to suppose that they were the *rubbers* of the rocks, and that they were rubbed by the same process ; still we must view them as having been connected with a tenacious clay to secure their sliding, yet allowing them occasionally to shift their position or expose a new face to the rubbing agent. This part of the process appears to be involved in great obscurity.

Although the clay was sufficiently dense to retain the boulders floating confusedly in its substance, it was fluid enough to admit of motion in an easterly direction. It has now, however, parted with much of its original water, and must, by its consequent shrinkage, have produced many unequal pressures on the neighbouring materials.

The sandy portions, or the upper parts of the formation, furnish proof of numerous intermittences in the condition of the watery medium in which they were deposited. The layers of sand are sometimes very fine, indicating a period of comparative tranquillity. The gravel furnishes proof of considerable velocity, while the irregularity of the materials, the numerous interruptions, removals, upfillings, and inclined layers, give evidence of several periods of repeated turbulence. The gravel pits near Lochend, and likewise those at Dalry, furnish very varied and instructive examples of this intermittent action.

It would be vain at present to seek for causes sufficient to explain the phenomena indicated by the series of closely connected facts which we have now enumerated and described. The *droppings of melting icebergs* and the *moraines of glaciers*, with all the adjuncts of submergence and elevation, may account for a small portion of these facts, but in this case the residual unexplained phenomena will prove in excess.

The excavation of our valleys, the rubbed surface of our rocks, and the incumbent superficial strata, have some important features in common, which the speculative geologist should keep steadily in view. The easterly direction of the agents appearing so prominently through the whole series of the phenomena, is an important element, nor is the presence of the assorting power of water in the basement and upper beds to be viewed with indifference. That a *debacle* of a singular kind has taken place, will scarcely admit of a doubt, although that notion is not free from difficulty, even if able to call to our aid *waves of translation*. We cannot explain the phenomena, but we trust the reader will give us credit for having indicated the facts of the case with sufficient minuteness and method, so as to point out the character his inductions should exhibit, and justify the designation Taragmite series which has been bestowed on the group.

There is very little to communicate illustrative of the animal and vegetable life of the period of the Taragmite deposit of the district. The only organic remain, indeed, which has been detected, occurred in a somewhat anomalous condition, and all that is known respecting it may be given in the words of Mr Bald, the intelligent engineer, who with praiseworthy zeal endeavoured to record all the circumstances of the case.

" As the Union Canal, which is now making betwixt this city and Falkirk, passes for twenty-eight miles through a country chiefly composed of this kind of cover, I took the opportunity of noticing if any organic remains were found in it ; and I requested my friend Mr Hugh Baird, civil engineer, who directs the canal operations, to be particular in his inquiries if any such remains were found, and to give me notice. Having been frequently along the canal with him for these last three years, I had an opportunity of investigating the excavations as they proceeded. No appearance of any animal or vegetable remain, however, was found until the 18th day of July last, when the workmen, who were cutting the canal, in the west park of

Cliftonhall estate, having undermined a large bench of earth, it fell, and a substance, which the workmen conceived to be the horn of an animal, was found amongst the earth, which, as a matter that attracted their curiosity, they laid in a cottage adjoining.

" Two days after this, in going along the canal, I met with Sir Alexander Maitland Gibson, who informed me that a singular remain of an animal had been found in cutting the canal through his estate; and he politely accompanied me to the cottage, that I might see it. On its being produced, I found it to be an ivory tusk, in most complete preservation. After taking its dimensions, and making a drawing of it, I went to the spot where it was found, and questioned the workmen particularly concerning it. According to their information, the spot where it was enclosed in the earth was from 15 to 20 feet from the surface; the earth or cover was of the strong old alluvial earth before described, and at the point where the banks begin to decline, and form the immediate narrow valley through which the river Almond runs. In the upper part of the earth where the tusk was found, I observed fissures about five inches wide at the top, and ending like a wedge below, formed by rents in the clay, and filled with sand. I have, however, reason to conclude, that the tooth had not been in the sand-veins, but enclosed in the clay; for, otherwise, it could not have been in such a complete state of preservation. From the close texture of the clay, and being so impervious to water, the tooth might, I think, have remained for ages in the same state. This spot I afterwards had the pleasure of examining, along with Professor Jameson, when I pointed out to him the situation where the tusk was found.

" The tooth weighed, when washed, 25¾ lb. avoirdupois, and measured as followed:

Length, ...	39 inches.
Circumference at the middle, .	13 do.
Circumference at the thick end, .	13 do.
Circumference near the small end, .	12 do.

And the inside curve deflected from the cord-line 4 inches and 2-10ths of an inch.

"As the specimen interested me much, more particularly as it was the only instance of my having found any organic remain in this kind of cover, I suggested to Sir Alexander Maitland Gibson to take particular care of it. He accordingly told the workman who found it, to send it to the house at Cliftonhall, where he would give him a gratuity for it. The workman, immediately upon understanding that what he conceived to be a horn was ivory, and very valuable, went off to Edinburgh with the tooth, and sold it. Sir Alexander, the instant he heard of this went in search of it, and found it in an ivory-turner's, who had given £2 for it; but, most unfortunately, before he arrived it was sawn across in three places, and part of it prepared for the lathe, to form chessmen; which circumstance shews the high state of preservation in which it was found. Sir Alexander repaid the money which had been given for it; and he has in the most obliging manner, permitted me now to exhibit it to the society."—(Memoirs of the Wernerian Society, vol. iv. p. 53.)

Little doubt need be entertained that this tooth belonged to a mammoth, and we may hope that other portions of the organism may be detected in the district. But grave doubts may be entertained as to its connection with the boulder-clay epoch. A fissure in the clay may have received the tooth and clay washed in along with it, and hence the state of preservation may be satisfactorily accounted for.*

I am aware that many organisms have occurred connected with clay in other districts, but proof is wanting that such clay is contemporaneous with the mass now under notice. There are, indeed, strong grounds for believing that boulder-clays may be of different ages, and even generated under considerably different conditions. Hence the great value of a rigid examination of the phenomena, in this district, as a type or standard, wherewith the occurrences of other districts may be compared. When the resemblances and the differences shall have been carefully determined, our generalisations may then be expressed with greater confidence. Meanwhile it is of importance to secure accurate observations respecting the character of the surfaces of the rocks on which the deposit rests, the character of the materials, and the evidence of intermittency exhibited in its upper members.

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* A portion of a tooth, much decayed, and without a label, exists in the Edinburgh Museum, which probably formed a part of the Cliftonhall specimen. Another part of a tooth, less decomposed and identical in character with the figure, plate 4. fol. 3, *ib.*, and equally unlabelled at present, is, without doubt, the specimen presented to the museum by the Earl of Eglinton. This tooth was found in the *tirring* of the sandstone quarry of Greenhill, in the parish of Kilmaurs, Ayrshire, in 1817, and preserved by the considerate zeal of Mr Robert Brown, tacksman. It was accompanied by another tooth, along with some small bones and several marine shells. These occurred in a light brown clay, the immediately surrounding portion of which was of a dark colour, and when turned up had a most offensive smell."—(*Ib.* 64.) These circumstances seem to indicate that the Kilmaurs deposit belongs to the Phanerite series.

CHAPTER VI.

Akumite series—Silt—Drift-peat, Sand, and Gravel—Organic Remains of Plants and Animals—Chalk Flints—Marine or Lacustrine Origin—Sand Hills—Erratics.

THE group of beds in the ascending series, now demanding consideration, will usually be found included under the term *Alluvium*. This name, however, is usually attached to the ordinary deposit in lakes and estuaries, or on the margins of rivers, and hence, if employed, would be too vague or indefinite. The phrase *Brick-clay Beds* would in many cases be appropriate; but many other beds belonging to older strata, such as the argillite of the coal-measures in the neighbourhood, are likewise extensively used for the purposes of the potter.

The group consists of three members, silt, sand, and gravel, varying considerably in character in the different localities. The examples are numerous, of easy access, and well exposed.

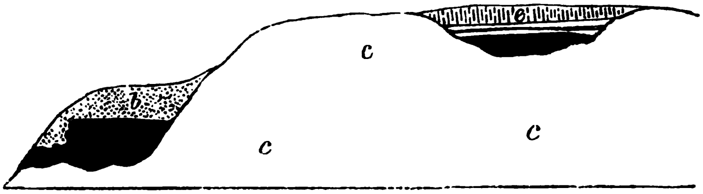
1. *Silt*.—This seems, in all the localities which have occurred for examination, to be the lowest or basement bed. It rests on the boulder-clay, where it is compact, and not on the upper or arenaceous portions of the mass. The surface of the boulder-clay, when fairly exposed, is uneven, with projecting but fixed boulders. Occasionally detached ones occur, resting on the surface, and surrounded on the sides and top by the silt. The evidence is indeed very plain that, subsequent to the deposition of the Taragmitic series, and previous to the commencement of the Akumite group, extensive denudations had taken place, by which the newer or upper portion of the former had been removed.

One of the most interesting examples of silt may be observed in the neighbourhood of Granton, on the terrace to the south of the harbour, and overhanging the village. The base of the bed, or the surface of the boulder-clay, may be about twenty feet above high-water mark. It is moderately even, and seems to have been a flat margin projecting from the terrace on the south, to which it is continuous by a gentle curvature. The bed at its northern or free edge is five or six feet deep, varying, however, considerably in the different portions which have been exposed. It thins off towards its south edge, where it joins the higher terrace on the north margin of the Golden Acre flat. At its junction with this last terrace, and where it thins off, there is no trace of ripple action, or margin of shingle, to indicate a sea-beach. The silt itself is of the same blackish hue as the boulder-clay, of which it appears to have been the finer portions washed out. The probability of this origin may be strengthened by washing out the finer part of the boulder-clay, and allowing the fine mud thus obtained to subside. The product will be a clay differing in no respect from the silt. The boulder-clay has a colour peculiar to the locality, being blackish in the coal districts, and reddish in the region of the old red sandstone, and the silt beds resting on it exhibit corresponding colours. The Eden in Fife is the colour boundary of the two series to the north.

The bed of silt is uniform throughout, and gives no indication of the carrying power with its suspended materials, having been subject to any intermittency. Even when the clay has been exposed for some time to the weather, the traces of stratification are extremely imperfect, a character almost peculiar to this bed. Its upper surface, however, immediately passes into a bed of coarse sand or gravel of a somewhat uniform character, with here and there films of finer materials, indicating a horizontal stratification, or rather a dip northward of four or five degrees. This bed of gravel, like the inferior silt, also abuts against the diluvial terrace, which forms the southern boundary of this silt basin.

No organic remains, as far as we have seen or heard of, have been discovered in the various portions of the clay which have been removed, or in its cover of gravel. Here, then, without determining whether this silt has been formed in an estuary or a lake, undoubted proof that water standing over this shelf of diluvium, and in comparative stillness, permitted the mud introduced to subside to the thickness referred to, continuously, that is without any obvious films of sand indicating intermittency, occasional freshets, or tides. The bed of silt, on its northern margin, seems to have been subjected to a washing or scooping out of its substance by ripple action, for the gravel has been observed to overlap the extremity of the upper portion of the silt, and to fill up some of the excavations. (See Fig. 5.)

Fig. 5.



a Silt-bed at Granton.
b The covering gravel.
c c c The boulder-clay.
d The Golden Acre silt.
e Upper, non-stratified bed.

The soil over the gravel bed, constituting the covering of the silt, is nearly horizontal, and seems to indicate its having been assorted by gravity in rather shallow water.

In the plain immediately to the south of this deposit of silt, and about a quarter of a mile from the northern margin or terrace to which we have referred, there is a hollow, and in it another apparently extensive deposit of silt has been exposed for brick-making purposes. As in the former example, the silt here rests on the uneven surface of the boulder-clay, without the intervention of gravel or shingle, and this floor is of a uniform compactness, resembling the inferior part of the diluvial bed. The silt here is more distinctly laminated, and it passes by alternations into sand at its upper part, with occasionally portions of gravel. The soil itself has been formed from a bed two or three feet in thickness of unlaminated tough light-coloured clay, into which the upper sand-beds imperceptibly pass. No organic remains have been detected in this deposit as far as known to us.

In looking at the sections from time to time displayed on the cliff between Granton and Newhaven, it appears that while the silt invariably reposes on the boulder-clay as its floor, it graduates above into various alternations of silt, sand, and gravel. To the south of our second example, and nearly at the same level, another deposit of silt was exposed a few years ago, and has been described by Mr Milne Home, in his valuable paper on the "Parallel Roads of Lochaber," p. 50 :—

"When the Edinburgh and Newhaven Railway was being constructed, there was found on the turnpike-road lying between Leith and Golden Acre, an extensive bed of sand about ten feet thick, below it a bed of peat one foot thick, below it a bed of laminated blue clay about ten feet thick, and below it the well-known boulder-clay. The bed of peat contained roots of trees, which evidently had grown in the clay, as their roots were found passing through the peat into the clay. These roots belonged apparently to the hazel ; but the only parts undecayed were the bark. In this peat-bed there were stems of reeds and other marsh plants, and numbers of small seeds of some shrub, not unlike those of a species of whin. These seeds, Mr M'Nab of the Experimental Gardens attempted to germinate, but without success. There was also some elytra of beetles. This bed of peat is from 70 to 80 feet above the sea. I traced it for at least 100 yards along the cut of the railway, in a north and south direction. How much it extends in an east and west direction, I had no means of ascertaining. But it certainly extends to the westward for at least a mile.[*] Over this bed of peat, there is, as already mentioned, a stratum of sand, which at the railway cut is ten feet thick, and appears to form a continuous deposit over all this district. That this thick bed of sand must have been deposited in deep water, is undeniable; and, therefore, I am inclined to hold, that when trees and shrubs were growing on the surface of the fine blue clay above mentioned, either the land here had sunk down, or the sea had risen, so as to submerge this ancient forest, and allow of the deposit of this extensive bed of sand over it."

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[*] "The late Captain Boswell of Wardie shewed to me a statement of the strata gone through in sinking two coal-pits on his property, which adjoins the locality alluded to in the text. At Pit No.1, which was 71 feet above the sea, *a bed of sand* 9 *feet thick* was first gone through, below which there was 15½ feet of clay, first soft, and then hard and stony. At Pit No. 2 (250 yards to the west of Pit No. 1), the first bed gone through *was* 9 *feet of 'sand and soft clay,'* below which was 21 feet of 'stony and black clay.'"

The existence of the bed of peat seems to have exercised no inconsiderable influence on the views entertained respecting the formation of the deposit. There is no evidence, however, that the peat was formed at the surface, like *forest-peat,* from the remains of felled or decayed trees. The roots in the silt, on which the peat rests, may have been drifted and embedded in the clay, before the vegetable matter was carried in to form what I have denominated DRIFT-PEAT, a material which has been little studied, and has consequently misled not a few speculating geologists. No *stumps* of trees with their roots penetrating the silt were observed, according to our inquiry, so that the drift-peat indicates no more than water standing over the silt, and that branches, leaves, &c., were floated in, as we see in many examples where lake-peat and drift-peat have been forming simultaneously. The covering bed of sand does not indicate the *depth* of water in which it was formed, nor is there aught of evidence respecting the *submergence of this ancient forest.* Indeed, the notion of "this ancient *forest*" is a dream, and the "obviously extensive *marine* deposit" (p. 51) covering it, is a suitable companion. Perhaps our author was influenced to some extent by a remark of Playfair, in the Illustrations of the Huttonian Theory, p. 443, or Works, vol. i. 434. "The ground on which the Botanic Garden of Edinburgh is situated (the old garden at Leith Walk), after a thin covering of soil is removed, consists entirely of sea-sand, very regularly stratified, with layers of a black carbonaceous matter, in thin lamellæ, interposed between them. Shells, I believe, are but rarely found in it, but it has every other appearance of a sea-beach. The height of this ground above the present level of the sea, is certainly not less than 40 feet." The assumption here of "*sea-sand*" and "*sea-beach*" seem alike unwarrantable from the description given of the sand, and, I may add, that the occurrence of sea-shells in the sand has not been since authenticated.

There are several rather extensive deposits of silt extending from the Hermitage and Rhynd Lodge, southwards to Restalrig, which at different places have been dug up for brick-making purposes. But as there are no pits at present open, we must pass on to Portobello, where this branch of the subject may be studied with advantage, as the exposure of the beds in section is very distinct. Here the silt, as at Trinity, rests on boulder-clay, and is of the same colour and character as the finer portions of that deposit. Some statements made by workmen, but not seen in section, would lead to the inference, that patches of gravel are occasionally interposed between the silt, and the floor of boulder-clay, but in all the junctions which I have observed, the silt rested directly on the boulder-clay.

The beds of silt are numerous, and generally laminated in structure, as well displayed after exposure to the air. The mass is divided into strata of unequal thickness by *partings* of sand, increasing in number and thickness towards the top where the clay disappears, and beds of sand or gravel support the soil. In one place at the north excavation, the surface of the clay indicated having been scooped out by various tracks of small rills, and these had been filled up by the deposits of the newer sands.

The indications of intermittency furnished by the thin partings of sand, separating the beds of silt, would, in the case of a lacustrine deposit, be referred to the occasional interference of freshets increasing the velocity of the carrying agents, and thus producing the alternations of fine mud and sand. To those who *assume*, that this mud was deposited in the sea or an estuary, and who believe that *mud* is supplied by rivers, while *sand* is "the natural product of oceanic waters," another explanation has been given. "The tides would in this respect have a considerable influence. As the largest supplies of the muddy sediment would be afforded by rivers, the deposition would be suspended, or at all events diminished, by every influx of the tide; when probably a slight sprinkling of sand would be thrown upon the muddy deposit, which took place during the ebb-tide. In this way, we can understand, how the laminæ visible in the Portobello brick-clay were formed; and if this inference be correct, then each layer of clay would denote the period of one tide, or half a day. As each layer is on an average about one-sixth of an inch thick, 120 feet, (which is supposed to be the thickness of the fine clay at Portobello) would denote a period of twelve years as the interval of its deposition." (*Milne on the Mid-Lothian and East-Lothian Coal Fields*, p. 81.)

The character here given of the mud formed under the influence of the tide is the veriest figment of the imagination, as any one who has access to a muddy beach may speedily satisfy himself. With regard to the period fixed upon, during which the clays were depositing, this otherwise painstaking observer has assumed a uniformity of tidal changes, very different from anything known at the present day. Twelve years of peaceful ebbing and flowing are here announced to have prevailed without a north-easter, a heavy surge, or a ground swell! Verily, the old sailors of Newhaven and Fisherrow would have cause to exclaim, "The former days were better than these!"*

In a section of the sand, near the house of Mr Livingston's works, there were several well-marked slips or dislocations, with shiftings of the bed to the extent of several inches. These slips observed the same rule so well known to coal-miners, viz. the beds being always higher on the hanging side.

In some of the sections of the clay not a trace of any organic remain can be observed, in other places considerable patches of *drift-peat*, more or less commingled with the clay, occur. The leaves of reeds and the branches of trees present themselves, and even trunks of oak, Scotch fir, birch, and perhaps other kinds, in groups or detached. Hazel-nuts have been reported as having been found, together with hawthorn, and even yew. These occurrences give tolerably distinct indications of a wooded country on the margin of the basin wherein the silts and the sands were accumulating, and of the occasional floods which, in such circumstances, take place.

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* The same author gives an interesting example of the "non sequitur" in his *proof* of the extent of the Portobello clay-bed. "I have reason to believe that a *similar bed of clay* exists in the Cowgate of Edinburgh, for I have heard, that in digging out the foundations of the South Bridge of Edinburgh, *a thick bed of cockles was discovered.*" Ib. p. 64.

Traces of marine remains do also occur in the silt. Thus in the excavations on the north side of the village, and the west side of the road, I have observed, irregularly distributed about the middle of the bed, small patches of rather coarse clean sand, commingled with dead or worn shells of *Turritella terebra*, *Trochus cinerarius* and fragments of *Cardia*. Small local currents had evidently brought them into their present position. At the south section of the excavation, at Mr Livingston's, where the layers of peat recently occurred, a number of shells of the *Scrobicularia piperata* were observed. According to Montagu, this shell is "chiefly found at the mouths of rivers or inlets, not remote from fresh water; and therefore never beyond the flux of the tide, yet it delights in situations where fresh water is occasionally flowing over. It principally inhabits sludge or muddy places, buried to the depth of five or six inches." These statements, in connection with the occurrence of the shells in the clay, at once led some to the belief, that here was an undoubted proof of the elevation of this land, since the present site of these shells in the clay is now upwards of twenty feet above high-water mark. Several circumstances, however, render such an opinion, founded on the occurrence of the shells, of very doubtful authority.

The shells were not distributed in the different beds of the section, but were consigned to a layer of the clay of about two feet in depth. They were irregularly scattered, horizontally and vertically, and all nearly *full grown*. Some of the examples consisted of detached or broken valves, others had the valves still united, but lying irregularly, while several shells occupied the same position in the silt, as they would have done if they had grown and died on the spot.

There can be no doubt that the sea had access to that spot, or other places in the neighbourhood, whence these shells may have been brought, at this particular period of deposition of the silt, but neither before nor after; and the proof seems clear, that being in position, they were alive when they burrowed in the clay. But had they lived there from youth to age? Here the proof is defective. Suppose an irruption of the sea into the basin in which the silt was forming, carrying dead and live shells, and distributing them on the top of the mud, all the appearances here pointed out would take place. The dead shells would sink irregularly into the mud, while the living ones in a few hours would *right* themselves and perish. Such is the explanation which the phenomena seem to warrant.*

Occasionally in the silt, a solitary rounded or angular stone may be detected, and very different in character from the fine mud and sand by which it is surrounded. We must here suppose some floating power acting in the comparatively still water. Trees, floating in the space, may have dropt from their roots the stones which they had carried from the soil; or ice, separated from the margin, might, in thawing, let fall the round pebbles which it had enclosed. The latter transporting power is the most probable, judging from other examples which I have witnessed. Several years ago the skull of an ox was found embedded in the upper portion of the sand.

2. *Sand and Gravel.*—The occurrence of sand and gravel, overlying conformably the inferior silt, renders it difficult to determine the age of the deposits of gravel around Edinburgh. The boulder-clay and the silt, may be observed alike, in passing upwards, graduating into sand or gravel; and in those cases where the gravel or the sand occurs without the presence of the inferior clay or silt, we have not the means of determin-

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* If a live razor or spout fish (*Solen siliqua*) be laid on the surface of wet sand, it will speedily begin to burrow, and right itself from the horizontal to the normal perpendicular position, and sink underneath, furnishing an interesting observation.

ing satisfactorily the true position. At Bonnington, on the Leith Railway, the gravel covered by sand was contemporaneous with the boulder-clay, whereas, at the Botanic Garden, at a short distance to the westward, the sand and gravel are newer than those of the silt. In like manner, we have no evidence that the extensive deposit of gravel and sand, in the low grounds to the westward of Dalry, are the upper Taragmite beds; and the same remark is applicable to similiar deposits around Gorgie Cottage. At this place, however, while the sands, in their irregular distribution in the layers, indicate great turbulency at the time of their arrangement, they are covered by a bed of *boulder-clay*, in some places exceeding four or five feet in thickness. The clayey basis is of a lightish brown colour, and the rounded stones are smaller and of a more uniform size than the usual inferior boulder-clay. The section was well displayed at the cutting by the Caledonian Railway, and attracted the notice of an intelligent observer, the late Sir George Mackenzie, Bart., who got an accurate drawing of the appearance executed, a copy of which he kindly presented to me.*

In contemplating the Taragmite and Akumite formations, there is evident proof of the operation of widely different agencies. In the case of the former group there is the appearance of a period of comparative stillness towards the close in some places, while in others the gravels and sands indicate violent commotions in the assorting power. In the latter, the fundamental bed, or silt, in its structural character, points to great tranquillity, while the incumbent sands and gravels indicate considerable agitation. Such phenomena, if considered in detail, receive no explanation from the ordinary hypotheses which are in circulation. But before any explanation can be offered with propriety, we may inquire if there be evidence that the silt has been formed in the sea or in an estuary, and, failing proof, are we to regard it as a lacustrine formation? There are difficulties in the way of arriving at a very satisfactory conclusion, and perhaps the greatest of these arises from a prevailing prejudice in favour of an elevation of the land, originating from imperfect observation, as we shall be able to point out when considering *raised sea-beaches*, said to occur in the neighbourhood.

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* A newer boulder-clay covers the silt and sand near the Dee at Aberdeen, and forms the bed on which Crown Street is built. These silt beds exhibit very remarkable examples of slips or dislocations similar to those referred to p. 72.

On the supposition that the silt was formed in the sea, how are we to account for the uniformity of structure throughout the thickness of the mass, indicating great stillness during the period of its formation, nor, at its margin, have we a trace of ripple action or the ordinary littoral sands and shells confusedly distributed. Viewing the silts as a lacustrine deposit, we are astonished at the extent of space which they occupy. Keeping in view the Granton and Portobello beds on the south side of the Forth, we observe similar beds in the same relation to the boulder-clay, and passing above into sands and gravel, to the eastward of Kinghorn at Tirie, Kirkcaldy, and other places. In this case we must conceive the water of the lake to have stood upwards of 100 feet above the present sea-level, or perhaps double that altitude, and may expect to find patches of its silt in many other places. Westward, in the Carse of Falkirk, the silt is found about the same elevation as the Granton bed and occupying both sides of the Forth, and extending by Stirling to Blair Drummond, and at a higher elevation in the neighbourhood of Clackmannan. Northwards, at the mouth of the Eden, and in the valley of that name, to the westward of St Andrews, and inland to Cupar, the silt is of a brownish colour. In the Tay, the Carse of Gowrie is a similar formation to that of Falkirk, and the deposit extends from Longforgan to Perth. Around the basin of Montrose, instructive examples likewise occur. In the vicinity of Aberdeen, silts, with the incumbent sands and gravel, may be witnessed of precisely similar character, but of a reddish colour. If then we assume the existence of a lake receiving into its bosom the waters of the Forth, the Tay, the Esk, the Dee, and the Don, we must consider the margin of the German Ocean as far removed to the eastward, and in a condition respecting which our conjectures are unsatisfactory. The internal structure, however, of the beds seems to justify no other supposition.

The advocates for submergence and elevation point with confidence to the shells, in proof of the marine formation of the deposit, without proof that the distribution of the shells justifies such an opinion. We have already referred to the condition of the Portobello shells. The other examples are equally instructive.

At Tirie I detected, last autumn, several detached valves of *Leda truncata,* and two specimens entire of a very recent appearance, being covered with the epidermis. This shell has not been found in the Forth or German Ocean, to our knowledge, and may be considered as an interesting addition to the fauna of our silt period. A single valve of *Pecten similis* of a large size, about five-eights across, likewise occurred, together with a fragment of a *chalk-flint,* upwards of an ounce in weight. The substances here referred to, indicate having been transported from their native site and distributed through the silt, but in none of their aspects, except their marine origin, do they furnish the slightest proof of having passed their days at the spot where they were found embedded in the mud or brick-clay.

Flints have frequently been observed by different individuals, on the sea beach, along the shores of the Forth, but referred to ship ballast. The example found in the Tirie silt, at once indicates a different origin. Subsequently, after a good deal of ripple action by east wind, I detected large patches of chalk flints at the Black Rocks, and Mr Christie of Hawkhill has observed them in considerable abundance on a field to the eastward of the house, the subsoil of which belongs to the Akumite series. These occurrences of flint in the Forth, viewed in connection with those in Aberdeen, to be afterwards noticed, would lead to the conclusion that they derived their origin from wasted chalk beds, which at one period were probably connected with those of Denmark.

Towards the head of the Frith of Forth we find similar remains in connection with the silt, and in the case of the Carse of Clackmannan, Alloa, Stirling, and Blair Drummond, the marine remains occur in considerable abundance. Some solitary shells may here and there be met with, perhaps transposed for a second or third time, but the most interesting remains are the ordinary shells of the Forth, such as oysters, cockles, mussels, &c., distributed in a tolerably continuous bed, commingled with the silt, and occupying a position towards the middle of the deposit. The littoral and deep-water species, those that live in mud, sand, or on hard ground, are all intermingled confusedly in a stratum of two or three feet thick, in some places thinning off, and disappearing in others. The shells are huddled together, odd valves and pairs, but not in normal position, demonstrating that all were brought to their present grave by violent means. The marine remains do not occur in the *inferior* portion of the silt, where there is no trace of a sea-beach, but where the condition of the deposit indicates stillness. The clay *above* the shells is equally laminated and free from all proof of turbulence, so that the notion of submergence or elevation, lugged in to account for the phenomena, must be discarded.

The skeleton of a whale, about 72 feet in length, was found in the silt or *carse-clay* at Airthrey, Stirlingshire, at an elevation of 20 feet higher than the surface of the highest tide of the Forth. Mr Bald, who published the notice of this occurence (Ed. Phil. Jour. vol. i. p. 393), adds, " There was found close by the skeleton two pieces of stag's horns, through one of which a hole appears to have been perforated of about an inch in diameter."

Another skeleton of a whale of nearly equal dimensions, and occurring in a similar position in the silt, was described by Mr Blackadder from Dunmore Park (Ed. Phil. Jour. vol. xi. p. 220, and 415).

A third example was detected at Blair Drummond, or rather Burnbank, Monteith, fifteen miles westward of the site of the Dunmore specimen, under a stratum of *carse clay*, and immediately on the surface of a bed of peat. " They were embedded in the clay, and did not penetrate at all into the moss below." Mr Drummond adds to the notice, "It is a very singular circumstance that, along with these bones, there should have been found a fragment of a stag's horn, similar to that found along with the Airthrey whale, and having a similar round hole in it" (Wern. Mem. v. p. 440).[1]

There was communicated to the Wernerian Society (Dec. 18. 1824) "Notice by Mr J. W. Reddock of Falkirk, regarding the bones of a quadruped found in a bed of clay, and of razor shells found in a bed of sand under the clay near Camelon, 90 feet above the present level of the Forth" (Ed. Phil. Jour. xii. 399). Dr Knox had an opportunity of examining the remains of the quadrupeds, and found they "were those of a seal of the species still inhabiting the Frith of Forth (*Phoca vitulina*)" Ib. 400. The value of these observations is greatly reduced by the difficulty of determining the age of the clay and sand, even after the valuable contribution to the illustration of the "Superficial strata of the Forth District," by Alexander Blackadder, Esq. (Wern. Mem. v. p 424).*

The shells in the silt, or Carse of Gowrie clay, at Powgavie, on the north margin of the estuary of the Tay, are in character identical with those of the Forth at Clackmannan. Those in the Forth, however, are elevated a few feet above high-water mark, while those of the Tay are occasionally washed by the spring-tides. It is worthy of remark, that while on the north side of the Tay this marine interpolation is covered by twenty feet of silt, without the occurrence of a marine shell, there are traces of turbulence on the south side of the estuary, and nearly at the same plane, exhibited by coarse sand and gravel, but the shells are likewise wanting.

If we pass by the basin of Montrose, or the estuary of the Dee, we shall find on the Aberdeen coast, at Belhelvie, a very instructive section. Here a thick deposit of finely-laminated red brick-clay rests upon the ordinary boulder-clay, and is covered by the usual sands and gravels. In the middle of this bed of silt there is a black stratum, varying from a few inches to two or three feet, and elevated about forty feet above high-water mark. This dark-coloured layer consists of shells, and along with specimens of the more ordinary kinds of the coast, fragments, and some entire valves of *Panopea norvegica, Pecten islandicus* and *Tellina proxima*, may be observed. Rounded pieces of quartz present themselves, together with gneiss, caking coal, wood (probably birch), together with numerous chalk-flints, and even *quadrangular blocks of soft and hard chalk*, of the size of the fist. Looking at a section of this kind, the stillness indicated by the finely laminated structure of the red silt above and below,—the darker coloured shell-bed with its sands and boulders,—the proof becomes very strong that we have no trace of a sea-beach, but a demonstration of an irruption of the sea, of short duration, into the comparatively tranquil waters of a lake, and that the animal and vegetable matter, becoming decomposed, gave to the bed its dark colour.

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* Recently Mr Page has announced the occurrence of the remains of a seal in the silt beds in the neighbourhood of Cupar.

The conclusion, indeed, seems irresistible that the Akumite series must be regarded as a lacustrine formation, into which marine remains have been thrown by irruptions of the sea. The shells are not usually in their natural position, or in the natural *soil*, and are in conjunction with those with which in a living state, they are never associated. It may be added that those beds of silt do not, probably, all belong to this period. The beds of Golden Acre, occupying a higher position, may be much older than those of Granton, while the *Carses* of Falkirk and Gowrie, are probably contemporaneous.

We would earnestly recommend the study of the Scottish silts, to all our zealous observers. If they determine the position of the deposits, their characteristic structures, and the extent of their horizons, indicating the distribution of the waters, we shall speedily extend our present very slender acquaintance with the changes which our country has experienced, since the *rubbers* were in operation and the surfaces of our rocks were *dressed.*

The equally interesting gravel and sand beds, constituting the upper portions of the group, merit careful investigation.

Although, in many cases, these are assorted with considerable regularity in horizontal strata, in other instances, the unconformable character of the different parts of the bed to one another give striking proof of turbulence. The condition of the surface, where no extensive artificial change has taken place, indicates the materials to have been assorted under the action of strong currents and eddies in comparatively shallow water. The extensive basins occurring on the surface of the deposit frequently forming receptacles of water in winter, and in many cases lakes of a more permanent character, are proofs in illustration. The older inhabitants of Edinburgh may remember the state of the ground to the north of Queen's Street, before the northern portion of the New Town was built. The surface exhibited innumerable ridges and hollows, many of them of considerable extent, so that the levelling of the ground for building was, in several places, a laborious operation, and in some of the damp hollows, the foundations were laid on piles, surrounded by the sand and gravel * The unequal ground chosen for the Experimental and Botanical Gardens, is a portion of the same deposit, exhibiting, even after all the shiftings of the soil, unequivocal proofs of the original unequal surface.

Between the Tay and the Eden, in Fife, very remarkable truncated cones of sand and gravel occur, with their flat surface occupying the same height as if the ripple action of standing water had reduced their summits to the same level. Mr Chambers, in his interesting and laborious work on "Ancient Sea Margins" (p. 54), supposes these cones to have formed a portion of a continuous plain, or sea bottom, when the sea stood 107 feet above its present line, and that, "sinking gradually to other levels, the uneasy element, with the aid of the stream, ate out these hollows, leaving only portions of the original surface entire." This explanation may account for the truncated cones, but leaves unexplained the obvious appearances of numerous basins in the generally waved surface of the gravel in the neighbour-

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* Not long after the erection of this portion of the city, a complaint known at the time as the "Aristocratic Fever," raged in the place, and was peculiarly rife in the houses built on piles, where damp hollows had formerly existed.

hood, the margins of which are below the level of the cones. Such basins may be observed at the farms of Wormit and Newton.

In the neighbourhood of Aberdeen, and northwards to Behelvie, extensive masses of sand and gravel, with the surface formed into edges and hollows, merit observation. Professor Agassiz, on looking at these accumulations in 1840, assured me that he regarded them as *moraines*. I have not been able to assent to this conclusion, from looking at the configuration of surface, and satisfying myself of their formation posterior to the silt. Indeed, rolled masses of the silt are not unfrequently found among the materials of the gravel pits.

The history of *erratics* or boulders resting on the surface, and different from the neighbouring rock, may be here appropriately noticed. Mr Maclaren refers to a block of mica-slate on the east end of Hare Hill, reposing on the surface of the west side of the glen leading from Habbie's How to Bevelaw. He estimated its weight at from eight to ten tons (Geol. Fife and Loth. p. 220). Similar spoils of the Grampians, which have been brought to this district, have occasionally been met with in other places.

The boulders of greenstone, however, are of most frequent occurrence. Several of these are noticed by Mr Maclaren as occurring on the Pentlands from two to fourteen tons weight; and Professor J. Forbes has described one about ten tons in weight, situate in the opening of a valley named Haw Dean, which lies between the hills of Allermuir and Cape Law, at a short distance behind the house of Dreghorn, and 748 feet above the sea. (Edin. New Phil. Journ. vol. vii. p. 257.)

Examples of easy access are by no means rare in the immediate neighbourhood. Thus numerous rounded masses of greenstone resting on the surface may be observed on the south eastern slope of Salisbury Craigs. A large greenstone boulder forms a sort of guard to St Anthony's Well, while another invites inspection as it reposes on the eastern slope of Dunsappie.

Sandstone erratics are likewise occasionally met with. Mr Maclaren notices one on the east end of the North Black Hill

(Pentlands) of eight tons weight. On the west side of the greenstone island of Cramond Mr Bryson has detected a block of sandstone. Indeed, in very many places of the district *erratics* of different kinds may readily be detected. They are not unfrequently denominated *Heathens* by the workmen engaged at the plough.*

To those who have studied the materials constituting the gravel beds, whether connected with the boulder-clay or the silts, there will be little difficulty in assigning to them a westerly origin, or to refer their transport to the abrading and transporting agents which have been so frequently referred to. The circumstance of their detached or isolated condition, has suggested to some that they may be regarded as the weightier remains of the gravel, the lighter portions having been carried off,—an explanation which in many cases seems satisfactory. Others have recourse to glaciers and icebergs, agents which, although well fitted for the task of transportation, could not, in many cases, have given the blocks the positions they now occupy.

In the infancy of geology a cause was assigned for the transport of these blocks, not now employed by men of science. Thus, on the south shore of the estuary of the Tay, six miles below Newburgh, and about two hundred yards west from Flisk Point, there is a larger boulder of sienitic gneiss fifteen tons weight, lying on the beach and forming rather a conspicuous object. According to tradition, when the building of the church of Flisk commenced, as the first place for Christian worship in the district, a Pagan giant, who lived on the opposite hills of Perthshire, was greatly offended, and, anxious to destroy the edifice, threw against it the large stone, which, falling short of the mark, remains on the beach to this day. Here observation had led to the conviction that the block was not a piece of native rock, but had come from a distance, and the popular notions of the period readily provided the means of transport, for debacles, glaciers, and icebergs, were unknown in the science of the day.*

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* The term *heathen*, in the neighbourhood of Aberdeen, means a bad stone, or one that will not admit of dressing like granite.

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* This explanation of the Fife example is the more remarkable, because one nearly similar is recorded by Linnæus in his Lachesis Lapponica, or Tour in Lapland. Near Hasjo and the mountain Balingsbergat, in Medelpad, Sweden, he says, "Not far distant, close to the church on the north-east, a huge stone is to be seen. The credulous vulgar relate that, when a church was building, some malignant beings of gigantic size were desirous of knocking it down, but the stones thrown for that purpose fell short of the sacred spot. As a confirmation of this history, they shew the evident marks of four huge fingers and a thumb on the upper side of the stone." (*Smith's Linn. Tour in Lapland*, vol. i. p. 46.)

CHAPTER VII

Phaneritic series—Raised Beaches—Sea Margins. Ayres. Caves—Sand-drift—Muirband or Pan—Lake Deposits.

THE group of strata now remaining to be considered, presents characters so easily observed, that one may well be surprised that any difficulty should have occurred, either in the description or explanation. A few only of the series present themselves to our notice in this district, of which the first is the most interesting.

1. *Raised Beaches.*—It has been announced by nearly all our local geologists, that there is a belt of level land around the coast, and raised several feet above the *grass line* or ordinary high-water mark, containing, along with sand and gravel, numerous remains of marine shells. It is also announced that the level land terminates inland, at a greater or less distance from the present beach, immediately at the base of a cliff or terrace which had occupied the position of a sea-margin; and that the rocky cliffs contain caves, the mouths of which are at a considerable elevation. It has been assumed, in order to account for this level belt and these caves, that the sea formerly occupied the place of an ordinary beach between high and low water, but that, in consequence of an upheaval of the land, this beach now appears at a higher level, and may be regarded as a proof of an elevating process. Instead of adopting such hypothetical notions, which unfortunately have passed current in this quarter for the last score of years, and have been earnestly advocated by such observers as Maclaren, Milne Home, and Hugh Miller, in which considerable liberties have been taken with molluscan life, on, apparently, very slender acquaintance, we shall venture to discuss the subject and examine the proof adduced.

Meanwhile, it may be stated that there is required for the examination of this deposit of marine matter, above the present sea level, an acquaintance with the habits of the animals, the relics of which are appealed to as furnishing the requisite evidence, with the mode of distribution of the materials of a beach, and with their relation to the shell-fish attached to them, together with the peculiar oscillations of the sea in its statical and dynamical condition. That these requisites have not been possessed by all our speculators will very easily be made manifest.

Mr Cunningham is perhaps the only local observer who seems to hesitate respecting this generally received notion of upheaval, for he says, " That some of these deposits of existing shells are in situations relative to the sea, which its present level and other circumstances seem inadequte to place them in, we may at once affirm ; but there certainly seems to be no reason why such appearances should be referred to a rising of the land, rather than to a local recession of the sea, and, if we consider the esturial character of the firth, perhaps the latter may be most likely." (*Geol. of the Lothians*, p. 117.) As the peculiar changes, by which the surface of the sea in the Forth might be permanently depressed, have not been mentioned, we are not in possession of the means by which to judge as to the probability of such an event, and, we may add, that the internal character of this belt of land furnishes proof, as we shall presently point out, that such an explanation is unsatisfactory.

Mr Milne Home, in his valuable Memoir, to which we have so frequently referred, seems to have adopted the upheaval notion without reserve. In reference to this deposit, at Skateraw, near Dunbar, he states, that it " contains numerous fragments of limestone, derived most probably from the strata of limestone which occur in the immediate vicinity, to the north and west. Most of these limestone fragments are bored with *Pholadæ*, and I found the shell in the stone. Moreover, some of these fragments had smooth surfaces, and on some of them I found numerous specimens of *Serpulæ* and *Patella vulgaris* sticking. These shells are now, therefore, in the exact situation where they lived. At this place the shelly deposit is thirteen feet above high-water mark," p. 70.

The occurrence of blocks of limestone, whether at thirteen or thirty feet above high-water mark, perforated by *Pholadæ*, and the shells sticking in the holes, is no proof that these remains are in the exact position in which they lived, *unless in reference to the block of stone.* If Mr Milne Home had stated, that in all the blocks the holes with the shells were placed perpendicular to the horizon, the upright position being the natural one, his proof that the blocks had not been tossed about but simply elevated, would have been deserving of attention. But not aware of this feature of pholadean life, very different from the irregular boring propensities of the *Saxicava arctica*, he jumped to the conclusion, that blocks perforated by a pholas must have been covered at the time of the excavation by the tide, and since elevated, but preserving their natural position. We can supply this defective observation, having visited the spot, and can assure the reader, that the direction of the holes has no uniformity, but, on the contrary, furnishes satisfactory proof that the blocks had been lifted from their bed and irregularly distributed on the banks. The serpulæ, being cemented to the rocks, could not readily be displaced, and the limpets, *still found adhering*, had been prevented from crawling or falling off, by the mass of sand and gravel in which they were imbedded. They died on the spot, but their death was a *violent one.*

The same author records, as another example of upheavel, a mass of sea-shells sixty-two feet above high-water mark, half a mile to the east of St Colme Lodge, between Aberdour and Dalgetty Church. He says, "I found in the cleft of a sandstone rock a confused heap of oysters, limpets, and whelks." (*Parallel Roads of Lochaber*, p. 28.) This mass occurs towards the top of a wooded bank immediately eastward of the Lodge, and about a mile to the westward of Aberdour. On visiting the spot shortly after the discovery was announced, there did not appear the slightest trace of sea-sand or gravel. The shells were all of the *edible* kinds, and were imbedded in a brownish clay soil, in which I observed fragments of splint coal and a *coal-cinder*. Recently I had an opportunity of looking at them, and observed at one place two limpets, one within the other, and in another place a string of four similarly inserted. Weak must be the evidence in favour of upheaval, if such an example be regarded as yielding any support.

Mr M. Home has likewise stated, that "at Joppa, and at a height of from two and a half to three feet above high-water mark, a stratum of fire-clay, which was excavated for working two years ago, was found extensively perforated by *Pholas crispata*, which exists now in the Firth, but is never known to live higher than half tide. The borings indicate, therefore, a change of level to the extent of nine or ten feet at least." (Ib. p. 26). This excavation has been obliterated, so that no satisfactory examination of appearances can be executed at present.

Mr Maclaren, in his *Geology of Fife and the Lothians*, p. 228, adopts, in like manner, the notion of upheaval, and states unreservedly that "there is satisfactory evidence to prove, that the bed of the Firth of Forth, and the land on both sides of it, have been raised twenty feet or more, at an epoch which, though very recent, geologically speaking, is probably long anterior to the records of history." The proofs adduced in support of this opinion are nearly similar to those already noticed, and liable to the same objections. He says, "The stratum of gravel in which the shells were chiefly found was from six to eight feet above the highest spring-tides, and about twenty-six or twenty-eight feet above the lowest level of low-water. Now, oyster-beds are found at all depths to 100 feet, but never, I believe, in spots left dry by the ebb-tide. The oyster-shells in the gravel were, therefore, about thirty feet above the level where the fish now lives; and the same remark applies to most of the shells found along with them; while the mussel, which is absent from the deposit, has its abode between high and low water."

There is here an appeal to molluscan life which merits consideration. That species of the genus OSTREA may be found at the depth of 100 feet will readily be admitted; but where is the proof that the common oyster (Ostrea *edulis*), the *species* under consideration, ever lives at so great a depth? On our coasts it is dredged in five or six fathoms, and in some places occupies such shallow ground as to be fished up with a rake. In reference to the wader, termed Hæmatopus *ostralegus*, Brisson, in his *Ornithologie*, says, "On le trouve sur le bord de la mer, où il mange beaucoup *d'Huitres;* ce qui lui a fait donner le nom d'Huitrier," v. 42. Pennant, in the well-known work British Zoology, is more explicit, for he says, "On the coast of France, when the tides recede so far as to leave the beds of oysters bare, these birds feed on them, forcing the shells open with their bills," Vol. ii. p. 482. But even admitting the depth of water in which oysters live, their appearance in this deposit has no resemblance to their arrangement in their natural bed. They are distributed among the sand and gravel in such a manner as to indicate that they have been borne from their residence and assorted by moving water.

This author has more recently furnished what he considers undoubted proof of the upheaval of the land, as indicated by a bed of cockles which he has examined at Bo'ness, and which we shall give in his own words,—"This deposit of shells is situated about a mile and a half west from Borrowstounness, where the Carse of Falkirk terminates in a strip of flat land a furlong in breadth. The shells are exposed in two openings, each about 300 feet long, made in the soil to procure limestone for Mr Wilson's ironworks. The bed can be traced in these openings along lines having an aggregate length of 1000 feet. Over all that space the shells form an unbroken stratum of very uniform depth (nearly three inches), and almost perfectly horizontal. They are covered by a bed of dark-brown sandy clay, from two to three feet thick, and rest on a deposit of the same substance, which closely resembles the mud spread over the present beach. The shells are all of one species, the cockle, or *Cardium edule*, and of various sizes down to the most minute. They are mixed with a portion of the clay which covers them, but lie so compactly, that they present to the eye the appearance of a layer of chalk nodules. Very few of them are fractured, and the two valves are generally united. The openings reach within twelve or fifteen yards of the high-water line; but the number of broken shells seen on the beach shews that the bed had once extended further northward, and that part of it has been cut away by the sea. The bed is at present about the level of high-water, or a little above it, while the natural abode of the cockle, according to Mr Broderip, is from the low-water line to a depth of thirteen fathoms. The continuity of the bed, its regular level, its remarkable uniformity, its composition confined to a single species, and the state of the shells, which are generally entire, and have the two valves united, shew that they are in their native locality, and prove that they could only have been brought to their present position by an upheaval of the land. This upheaval must have been to the extent at least of eighteen feet, which is the difference betwixt high and low water, but very probably it was to the extent of twenty, thirty, or forty feet. Inundations of the sea, caused by storms, have been called into account for such deposits, but, in my opinion, very inconsiderately. That a sudden and violent movement of the sea should sweep away a bed of shells from its original locality, is intelligible enough; but that, while transporting them over some hundred feet or yards, it should preserve them unbroken, with the valves still united, — that the rushing water, instead of ploughing up the dry land it invaded, should smooth and level an area of more than an acre, then spread out shells upon it with mathematical regularity, in an uninterrupted stratum of nearly uniform depth,—that, finally, it should cover them with a bed of clay two or three feet thick, and then withdraw;—these seem to me to be effects utterly irreconcileable with the known agency of floods. I would as soon believe that the West Indian hurricane, instead of levelling the planter's house, transports it *en masse*, with its walls, roof, and furniture all entire, from one end of a field to the other." (*Proceedings of the Royal Society of Edinburgh*, vol. ii. p. 265.)

It is matter of regret that this diligent observer, in the absence of an acquaintance with the bearings of the question, has indulged in a dogmatical style while describing a subject which he should have handled cautiously. His description of the bed does not contain a single remark enabling us to decide whether the cockles were found with their heads or their heels upwards. They were, indeed, so huddled together, like "a layer of chalk nodules," as to give good grounds for believing, in the absence of prejudice, that they were not in the ordinary position of cockles in a sand-bed. But the most surprising part of the statement remains to be considered, viz. the reasons for determining the amount of the upheaval of this bed to have been eighteen, twenty, thirty, or even forty feet. He quotes, as authority, "the natural abode of the cockles, according to Mr Broderip, is from the low-water line to a depth of thirteen fathoms."

But the individual referred to is not indicating the abode of the *common cockle*, but the genus *cardium*, species of which, Mr Broderip says, are found from "at or near the surface of the water—to thirteen fathoms." (See Broderip's table in the appendix, De la Beche's Researches in Theoretical Geology, p. 402.) No fact is better known, although for particular purposes frequently overlooked, that the following rule as to species holds true—that while knowing the physical and geographical distribution of a few *individuals* of a species, we can, with tolerable safety, predicate respecting the remainder. But although acquainted with the physical and geographical distribution of a particular *species* of a genus, we are not justified in concluding that the character of any other species of the *genus* will be similar. These rules are strongly illustrated in the genus now under consideration. The common cockle, or *Cardium edule*, lives in sand-beds, from about mid-tide to the lowest ebb. The *Cardium echinatum*, on the other hand, "inhabits various depths of water from seven to eighty fathoms, all round our coasts." (Forbes and Hanley, vol. ii. p. 10.) It never occurs exposed by the retiring tide. Mr Maclaren can easily satisfy himself as to the locality of the common cockle, and the *C. echinatum* may occasionally be found in the Newhaven boats, having been dredged from the oyster-beds;

but the two species are never found in company during life, although associated in raised beaches, so that the whole proof of upheaval rests on a misinterpretation of cockle life.

The late Mr Hugh Miller, a keen advocate of the upheaval notion, fancied that at the mouth of the Foul Burn, on the beach east from Seafield, he had found stones in the same position as they occupied when the oyster, limpets, and serpulæ which he found attached to them, had lived. This supposed fresh proof he communicated to a meeting of the Royal Physical Society, Dec. 27. 1854, "On a raised sea-bottom near Fillyside Bank, between Leith and Portobello." On examining the spot, however, it was no difficult matter to perceive that his affection for a favourite vision had led him to be contented with looking at those stones which countenanced his views, and to overlook others of a decidedly contrary character, such as limpets adhering to the under sides of stones imbedded in clay, where they never either lived or moved. After the locality was fairly examined, we heard no more of the matter.

Upwards of fifty years ago, on examining a bed of shells on the south side of the Forth, a continuation of the so-called "raised beaches" of this neighbourhood, I was led to conclusions widely different from those which have since prevailed, and which I published in "Thomson's Annals of Philosophy," vol. iv. p. 133. As this communication has been overlooked by those otherwise meritoriously diligent in their researches, I shall here quote extracts of portions bearing on the point under consideration. "The bed of shells which I am about to describe occurs to the westward of the town of Borrowstounness, in the county of Linlithgow, and stretches along the banks of the Firth of Forth into Stirlingshire.

"The shells which are found in this bed are all of them inhabitants of the sea, and still exist in a living state. The common oyster occurs in the greatest abundance, and occupies more than three-fourths of the bed. The common mussel may also be observed, but in small quantity. The following shells occur more sparingly: *Patella vulgaris*, *Buccinum undatum* and *lapillus*, *Turbo littoreus*, *Nerita littoralis*, and *Venus pul-*

lastra. There is little sand or clay mixed with these shells, so that the bed is very open in its structure. In the cavities formed by the shells resting upon one another I observed the remains of several land shells. But a very superficial examination convinced me that these were to be considered as foreign to the bed. In search of nourishment and shelter, many specimens of *Helix lucida*, *rufescens*, *nemoralis*, and *radiata*, were, at the time I examined the bed, crawling among the marine shells, and dead specimens of these were very common in the cavities.

"Many of the shells contained in this bed are of a very large size, and must have belonged to very aged individuals. Among the bivalved shells, there are a few perfect specimens, having the valves still in contact. But in general the valves are detached, and the shells broken into moderately-sized fragments, so that the bed presents an appearance of confusion. The shells themselves are a little altered in their texture. They are soft and friable, occasioned by the decomposition of the animal portion of their constitution. The epidemis is completely destroyed, together with the ligaments.

"This bed appears to vary in thickness. Towards its eastern extremity, where it is distincly seen, it is upwards of three feet. It there rests on a bed of small gravel, and is covered with clay and soil. It preserves, in all the parts of its course, nearly the same elevation above the surface of the river. In one place I ascertained its height to be thirty-three feet above high-water mark.

"The shells in this bed are in many cases broken; but the fragments are angular, and present no marks of continued attrition. In this respect they prove themselves to have been deposited in a hurry, and not to have been transposed from any distant quarter.

"In examining the exuviæ of the testaceous mollusca thrown up by the sea during ordinary storms, we find young and old shells blended together, but, in general, with a greater proportion of the latter than of the former. In this bed few young shells appear. Torn first from the rocks, they have probably been reduced to sand, while their aged sires have been raised by violence from their beds, and shortly after have been thrown up in the state of confusion and disorder in which they are at present to be observed.

"From these facts I am disposed to conclude that this bed of fossil marine shells has been thrown up during some violent agitation of the sea, when the waves rose at least thirty-three feet above their ordinary limits.

"This conclusion receives support from the appearances presented by beds of marine shells which have been thrown up by the sea during violent tempests. Thus on the shore to the westward of St Andrews there is a bed of shells a little elevated above high-water mark, and covered with the blowing sand which forms the *links*. This bed is nearly a mile in length, and about two feet in thickness, and presents the same general appearance of confusion which we have noticed in the bed of shells of the Forth. It is almost entirely composed of broken and detached valves of the *Lutraria vulgaris* irregularly huddled together. During gales of wind the sea throws up at present a few of these shells, and in the time of a violent tempest (or what is termed by the fisherman a *grund-storm*) considerable quantities are cast up. These shells are found buried deep in the sand beyond low water. During the gale which brought these shells ashore the bed of sand must have been removed by the tide, and then the shells themselves transported to the shore. But to effect this a tempest infinitely more violent than any of those which have occurred for many years past must have happened. At present I can procure no information concerning its date.

"Near Odness, in Stronsa, Orkney, there is another bed of marine shells, which has been deposited by the sea during a tempest. It is described by Mr Neill in his Tour through Orkney, p. 27. This bed is elevated but a few feet above the high-water mark. It is entirely composed of detached valves of the *Pectunculus pilosus* and *Pecten maximus*, of a large size. Similar beds are found in the island of Sanda. These shells are not littoral, like those which constitute the beds at the Forth and at St Andrews. They inhabit deep water, and must have been forced to the shore by a very violent agitation of the sea. The natives of the island still remember this dreadful tempest, which occurred about thirty years ago, and which threw up in the course of a single night several hundred cartloads of these pelagic species.

"We have very few accounts left us of great inundations of the sea which have taken place upon our coasts. Boece in his *Historia Scotorum*, book iii. gives us a short description of the effects produced by a violent tempest which took place about the year 1266. 'Anno regni Alexandri tertii septimo et decimo, tanta inundatio, nimio plus solito maris estu per tempestates alveos excedente, facta est, præsertim Tai et Forthеæ fluviorum, ut multas villas ac pagos prostraverit, maximamque cladem cum hominum tum pecorum dederit.' Fordun supplies another fact in the history of this tempest, by stating that it came on accompanied with a violent north wind, and that its ravages extended from the Tay to the Tweed.

"Such a storm must have left some visible traces of its existence. Tradition, indeed, mentions one of the effects of this mighty flood, in the destruction of a town, and in the elevation of the sands of Barry, at the mouth of the Tay. And what prevents us from concluding that the same mighty tempest raised from the bottom of the channel of the Firth of Forth the oysters and mussels, and deposited them in a regular bed along the banks of the river?"

Were we dependent on the narrative of Hector Boece we might perhaps feel ourselves justified in hesitating about adopting *marine inundations*, as explaining the phenomena in question. But when there are subsequent historic proofs of similar irruptions, there can be little difficulty in viewing his testimony favourably. The shores of Fife, Forfar, Aberdeen, Moray, Cromarty, and Sutherland, can furnish proof that such tumultuous risings have taken place; and in other lands similar phenomena have been recorded. Sir Charles Lyell, in his PRINCIPLES OF GEOLOGY (1850), states, as one of the accompaniments of the great Lisbon earthquake (1755), "A great wave swept over the coast of Spain, and is said to have been sixty feet high at Cadiz. At Tangier in Africa, it rose and fell eighteen times on the coast. At Funchal, in Madeira, it rose full fifteen feet perpendicular above high-water mark, although the tide, which ebbs and flows there seven feet, was then at half ebb. Besides entering the city and committing great havoc, it overflowed other sea-ports in the island. At Kensale, in Ireland, a body of water rushed into the harbour, whirled round several vessels, and poured into the market-place" (p. 478). He afterwards adds, in reference to an earthquake disturbance of the sea in Peru, 28th October 1746, "There were twenty-three ships and vessels, great and small, in the harbour of Callao, of which nineteen were sunk; and the other four, among which was a frigate called St Fermin, were carried by the force of the waves to a great distance up the country, and left on dry ground at a considerable height above the sea" (*Ibid*, p. 463).

If we have evidence that *storm waves* have destroyed villages with men and cattle, and that *earthquake waves* have driven even frigates on the land, are we to hesitate about admitting the power of the same agent to throw up on the land oysters, mussels, sand, and gravel? When, therefore, we observe beds of sand with marine remains, how are we to determine their origin? Will their internal or structural character compel us to refer them to storm waves or earthquake waves? In all the cases in the neighbourhood of Edinburgh, on the shores of the Forth, this reference to storm waves is unavoidable, and would have been adopted had not hypothesis misled, and a want of acquaintance with zoology favoured the delusion.

Eight or ten years ago there were some remarkably interesting displays at Granton quarry of this bed of marine materials, four or five feet thick, and resting on the sandstone and boulder-clay. There were few and indistinct traces of intermittent action, such as might have been looked for in a littoral bed, formed at intervals throughout several years. The materials, from top to bottom, were confusedly intermingled, and small and large stones were irregularly distributed throughout the mass, from the size of a nut to upwards of a ton weight. Those blocks which were of a broad flat form had taken up a position dipping to the north-east, and thus unequivocally indicated the direction of the current at the period of their distribution. Stones on the beach of this form usually lie flat in the sand, acted upon in different directions by the waves, this being the position offering least resistance. Many of the stones had one side smooth while the other was rough with gravel, limpets, and barnacles. The smooth side is common to stones within tide-mark embedded in sand or clay, while the free, or exposed side, is usually covered by animals and the lower algæ. If these blocks had occurred in the bed with their smooth side undermost, it might have been held that the stones had never been moved from that position since they supported life in the sea. But these boulders occupied all positions, and often with the smooth or underside uppermost. When I had the pleasure of pointing out these appearances to Sir Charles Lyell, a keen supporter of the upheaval notion, he at once admitted the proof of *tumult*, and thus weakened, if not abandoned, the evidence of elevation. If the notion of the marine-bed being an old sea-margin be adhered to, then it must at the same tim be assumed that a mighty storm tossed about the materials of the beach, and huddled together shells, stones, sand, and gravel, immediately after which commotion their elevation took place before any intermittant tidal action could have operated. To those who have consented to such suppositions, it would be vain to offer any objections, but allow them the peaceful possession of their dream. All the shells of this bed are such as are still found alone in the estuary. Mr Howkins has found the vertebræ and ribs of a whale in this bed near Granton harbour, and in one part of the same bed, near the old quarry, I picked out a solitary rib of the ox.

At Granton, as has been stated, the marine bed rests on rocks and boulder-clay. At Newhaven it covers the latter, the surface of which is nearly on a level with the high-water of spring-tide. At Portobello it covers some of the portions of brick-clay, and is newer than the two series of deposits which we have been considering.

2. *Sea Margins.*—It has been somewhat confidently stated, that the remains of a sea-cliff may be observed between Portobello and Leith, and at Trinity and Granton, against which the sea extended its fury when occupying relatively to the land a higher elevation than at present. At the base of this cliff, and extending seaward to the present grass line, there is supposed to exist the remains of the ancient sea-beach. In order to prove or disprove this opinion, it may be expedient to compare the modern sea-cliffs in the neighbourhood with those ancient ones which are appealed to.

There is a space usually occupied by stones or shingle confined within the limits of the flood marks of spring and neap-tides, and which is peculiarly exposed to ripple action. Towards the ebb mark the shore is usually smooth, but in the space referred to, which for the present may be termed *beach*, the coarser materials are collected together and heaped up in ridges of ever shifting elevation. But in looking at this supposed sea-cliff at Craigintinny, there is no observable trace of this shingly beach, but a uniformity of arrangement in the marine materials, very different from the production of ripple action. Let an observer study the appearance presented by the boulder-clay cliff at present acted upon by the sea at the *man-trap* already noticed, and the materials distributed at the base, and then examine, under the guidance of his acquired knowledge, the so-called sea-cliffs of the neighbourhood, and he will probably be disposed to conclude that a hasty superficial examination of appearance has misled.

If we attempt to trace these sea-cliffs with the view of establishing their continuity, we shall meet with difficulties of no ordinary magnitude. There is a breach at the Friegate Burn, and in connection with the valley through which it flows. The cliff does not exist on the west side of Leith Links, and although a terrace appears at Granton, there is no evidence of a sea margin.

The bed of shells, supposed to have formed a sea-beach, occurs in connection with the silt beds as well as the boulder-clay, and varies remarkably in the level from resting on the boulder-clay near high-water mark at Newhaven, to ten or twelve at the Maitland Burn or Leith Fort. It seems impossible to adopt the upheaval notion when all the circumstances of the case are calmly considered. The conclusion, indeed, seems fully justifiable, that these marine beds were of storm origin, as may be more readily assented to by the study of the *Ayres*, so frequent on all parts of the coast.

The advocates of upheaval appeal to rocky cliffs where *caves* occur which the sea must have formed, but cannot now reach. Between these cliffs and the present beach, there is usually a portion of flat ground composed of sea-borne materials, and elevated several feet above tide mark. There are no traces of such phenomena in this immediate neighbourhood, but very instructive examples occur on the shores of the Forth, of easy access, to the eastward of Wemyss Castle, and well known as the "Caves of Wemyss."

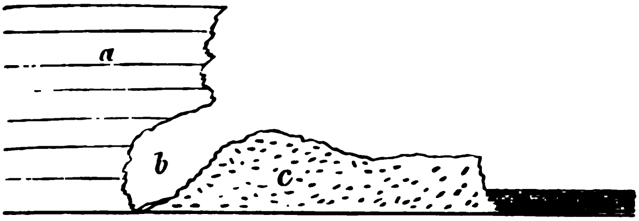
A number of these caves have been excavated in the sandstone, and at a period when the sea had direct access to the cliffs. If the confused and irregularly stratified materials, now constituting the flat between these cliffs and the shore, were removed, the sea would again exert its excavating influence, for the floor of the caves is lower than the ordinary rise of the tides. The question, what produced this flat of marine matter, must now be considered.

No one can have looked attentively at the state of the coast, without observing that in some places the sea is throwing up sand, gravel, and broken shells, during storms, which afterwards repose beyond the ordinary influence of ripple action. In other places, the *under tow* carried sea-wards the materials of the beach, gradually undermines the shore margin, and makes more or less rapid encroachments on the land.

This destructive influence has operated for many years past on nearly all parts of the shores of the Firth of Forth, and has been peculiarly active of late years at Joppa, Craigintinny, and Newhaven. The land-making tendency, on the other hand, seems formerly to have prevailed, and to have produced Leith

Links and the extensive flat on which the town is built.* At Wemyss the sea in like manner has excluded itself from the caves by throwing up the belt of flat ground, which has hastily been concluded as formed under water, and afterwards exposed by the elevation of the land.

Fig. 6.



a Sandstone cliff.
b Cave.
c Sea gravel.
d The sea.

The circumstance of the cave not having been filled up with the sand and gravel, may easily be accounted for by the stillness or regurgitation of the water ; while the elevated ridge of matter near the mouth of the cave may be due partly to the meeting of the currents, or to matter subsequently falling from the decomposing cliffs. The contents of the ridge countenances the former suppositions.

Even in those cases where the floors of the caves are higher than the ordinary tidal influence, there is no proof of upheaval assistance. But a small amount of the scooping out of caves is due to the sea in its ordinary state. When influenced by storms, it drives about in its fury destructive rubbers, and often in this its dynamical state, causes them to exert their abrading influence at heights considerably above ordinary sea level. Should the outworks of such a ridge be washed away, a cave will then open to day, with its floor higher than the present level of the sea. Such was the view which an examination of the cave of the Red Head suggested to my mind in 1815, and which subsequent observations have greatly strengthened. (See Wern. Mem. ii. 359).

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* An interesting example of the sea having excluded itself from the land occurs at the Bay of Nigg near Aberdeen. It has thrown up three or four ridges or embankments parallel to one another, the first of which cut off a portion of the upper part of the bay, converting it into a fresh-water lake. This lake has passed into a peat-bog, which, by making an opening through the gravel ridges, has been drained, and now constitutes the flat ground to the south of the old Church of Nigg.

In the Dornoch Firth a more striking instance occurs. At an early period the deposits indicate its decidedly marine characters by the shells included in its silts. It then occurred as a lake which the sea afterwards destroyed. At present a contest between the issuing of the fresh waters and the tides with the ripple and action is going on at the bar termed the Genzen Briggs. On the south side of the Estuary and to the east of Tain, the sea has excluded itself by a succession of sand ridges thrown up by storms, and is occasionally adding to their number; an extent of nearly four miles, known as *Morrich More*, has thus been added to the land.

3. *Sand drift.*—There are no well characterised examples of this group of superficial matter to be found in the district. Half a century ago, hummocks of drift sand abounded in the flat between Portobello and Leith. A considerable portion of this has been washed away to sea, and what remains has been levelled, irrigated, and rendered of great value for the heavy crops of grass which it produces. Formerly it was not worth one shilling an acre, now it fetches twenty or thirty pounds. Another example may be witnessed in the hillocks on Leith Links, and especially in the neighbourhood of Carolina Park, where the vegetation peculiar to drift sand may readily be sheded. In a few places I have observed a thin layer of peaty matter interposed among the beds of sand, indicating the destruction of a surface of vegetation, the result of a few years of tranquillity. It is well known to the agriculturist, but has hitherto failed to attract the notice of geologists. It seems to have originated in the burning of a surface of vegetation, the results of which have cemented the materials in contact, while soil by degrees has accumulated over the layer.

4. *Muirband or Pan.*—This is found as a stratum of sand, gravel, and clay, cemented by oxide of iron and carbonate of lime, and occurs about a foot under the surface. The best example which we have observed was exposed by trenching in the garden at Seafield, Leith.

5. *Lake Deposits.*—Duddingston Loch, at one time, furnished

marl to the agriculturist, but at present is only interesting to the observer, as an example of the process of upfiltering by aquatic vegetation. The lake on the west side, especially, would soon pass into a bay or morass if the reeds which now grow luxuriantly, were not annually cut down and removed for thatching purposes. The same proof may likewise be studied at Lochend. But the best example is presented by the Meadows. So late as the period of the erection of Watson's Hospital, this flat was occupied by the Borough Loch, as appears from a painting on the wall of one of the rooms of the institution, and taken from the Borough Moor on the south side. Although now drained, yet it is easy to trace a portion of the history of this now obliterated sheet of water. Immediately under the thin layer of soil, a bed of *lake peat,* from a few inches to upwards of a foot in thickness, covers a thin bed of marl. The shells which abound in the marl are those which may be found in all the ditches of the neighbourhood. The under bed consists of silt, sand, or fine gravel resting on the boulder-clay. Near Craigcrook a small lake still exists, out of which marl was at one time procured. Vegetation, including the naturalised *Stratiotis aloides,* is now rapidly filling it up.

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